DRAFT
ENGINEERING EVALUATION/COST ANALYSIS
12th STREET LANDFILL/DUMP SITE
WILMINGTON, DELAWARE

Prepared for

U.S. Environmental Protection Agency Region 3
1650 Arch Street
Philadelphia, Pennsylvania 19103

Prepared by

Tetra Tech EM Inc.
Eastern Area START Region 3
107 Chelsea Parkway
Boothwyn, Pennsylvania 19061

EPA Contract No. 68-S3-00-02
Technical Directive Document No. 03-00-11-002
Document Tracking No. 1148

June 29, 2001

PFE ORIGINAL

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TABLES

ACRONYMS AND ABBREVIATIONS

$\mu g/L$	Micrograms per liter
$\mu g/m^3$	Micrograms per cubic meter
AAQS	Ambient Air Quality Standard(s)
ACB	Articulated concrete block(s)
AOC	Area of concern
ARAR	Applicable or relevant and appropriate requirement(s)
AWQC	Ambient Water Quality Criteria
BDAT	Best demonstrated available technology
bgs	Below ground surface
BPA	Brownfield Preliminary Assessment
CAA	Clean Air Act
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
cfs	Cubic feet per second
Coastal Plain	Coastal Plain Physiographic Province
CWA	Clean Water Act
DNREC	Delaware Department of Natural Resources and Environmental Control
EE/CA	Engineering evaluation/cost analysis
EPA	U.S. Environmental Protection Agency
°F	Farenheit degrees
ft^2	Square feet
GRA	General Response Action
IC	Institutional control(s)
ID	Identification
J	Analytical data qualifier; estimated value
K	Analytical data qualifier; biased value
lbs/yd^3	Pounds per cubic yard
LDR	Land Disposal Restriction(s)
MCL	Maximum Contaminant Level(s)
mg/kg	Milligrams per kilogram
mg/L	Milligrams per liter
mg/m^3	Milligrams per cubic meter
msl	Mean sea level
NA	Not analyzed
NAAQS	National Ambient Air Quality Standards
NCP	National Oil and Hazardous Substances Pollution Contingency Plan

ACRONYMS AND ABBREVIATIONS (Continued)

ND	Not detected
NEPA	National Environmental Policy Act
NFA	No further action
OSC	On-Scene Coordinator
OSHA	Occupational Safety and Health Administration
PEL	Permissible exposure limit
Piedmont	Piedmont Physiographic Province
POTW	Publicly owned treatment works
PPE	Personal protective equipment
PRSC	Post-removal site control
RA	Removal Action
RAA	Removal Action Alternative
RAO	Removal Action Objective
RBC	Risk-based concentration
RCRA	Resource Conservation and Recovery Act
S/S	Solidification/stabilization
TBC	To be considered
TCLP	Toxicity Characteristic Leachate Procedure
TWA	Time-weighted average
USC	United States Code
Weston	Roy F. Weston, Inc.
yd^3	Cubic yard(s)

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EXECUTIVE SUMMARY

OVERVIEW

This document, while not a formal engineering evaluation/cost analysis (EE/CA), represents the results of an effort to evaluate remedies, including the remedy previously implemented under a time-critical removal action, to address threats posed by the 12th Street Landfill/Dump Site in Wilmington, Delaware; the EE/CA process was followed, because it presented the best available method to complete this effort in a timely manner. This EE/CA was prepared in accordance with current U.S. Environmental Protection Agency (EPA) guidance for a non time-critical removal action under the Comprehensive Environmental Response, Compensation, and Liability Act and Delaware Department of Natural Resources and Environmental Control (DNREC) guidance for hazardous substance cleanup (EPA 1993). This document summarizes the results of the EE/CA process, characterizes the site, identifies removal action objectives, describes and analyzes removal action alternatives, and defines the recommended removal action alternative.

SITE DESCRIPTION

The 12th Street Landfill/Dump Site is located along the eastern edge of Brandywine Creek in a moderately industrial section of Wilmington, Delaware. Based on aerial photographs and other historical information, primary waste disposal activity at the 12th Street Landfill/Dump Site began prior to 1950 and continued until sometime between 1968 and 1977. The Electric Hose and Rubber Company formerly manufactured industrial hoses in an industrial facility at the northern end of the site along Brandywine Creek; apparently, waste hoses and residue from a lead casting process used in the manufacturing operations were disposed of in the area now known as the 12th Street Landfill/Dump Site. The site consists of portions of various tax parcels owned by separate entities, including the Wilmington Economic Development Corporation, the State of Delaware Department of Transportation, the State of Delaware Department of Corrections, the Norfolk Southern Railroad Company, and a private citizen (EPA 2000c).

In June 1999, DNREC conducted an inspection of the area of the 12th Street Landfill/Dump Site as part of a Brownfield Preliminary Assessment targeted at properties along the eastern bank of Brandywine Creek near 12th Street in Wilmington. Based on data generated during this assessment, EPA was notified and requested to conduct additional investigations. Beginning in August 1999, EPA conducted a sampling assessment at the 12th Street Landfill/Dump Site in conjunction with DNREC. Analytical data generated from the assessment revealed the presence of elevated levels of lead (up to 264,000 milligrams per kilogram [mg/kg]) in soil at the site; in addition, the investigation revealed several drums exposed along the actively eroding bank of Brandywine Creek. In April 2000, EPA initiated a time-critical removal action at the site, primarily designed to address immediate concerns at the site related to the erosion of the creek bank, and the potential for migration of contaminants into Brandywine Creek. Additional sampling conducted during the time-critical removal action has also identified elevated concentrations of lead (up to 50,100 mg/kg) in soil on the northern side of 12th Street and the area addressed by the time-critical removal action; based on historical aerial photographs and waste materials discovered during the time-critical removal action, contamination in this area appears to be an extension of past waste disposal practices at the Electric Hose and Rubber Company facility (EPA 2000c).

OBJECTIVE AND SCOPE

The objective of this EE/CA is to provide an analysis of current site conditions (that is, post time-critical removal action) and to evaluate alternatives for potential, future response actions to be taken at the 12th Street Landfill/Dump Site and related areas of contamination. This report was prepared, in part, to assist DNREC and the State of Delaware in determining possible future response actions, which may be implemented at the 12th Street Landfill/Dump Site and related areas of contamination.

REMOVAL ACTION ALTERNATIVES

In order to address the stated objective, a screening of available and potentially applicable remedial technologies was conducted. As a result of the screening process and discussions with DNREC representatives, the following eight removal action alternatives have been identified and included in this EE/CA for further evaluation:

- Alternative 1 - No further action
- Alternative 2 - Institutional controls
- Alternative 3 - Soil cover over contaminated areas
- Alternative 4 - Excavation and off-site disposal (Subtitle C)
- Alternative 5 - Consolidation and containment
- Alternative 6 - Consolidation and injection stabilization
- Alternative 7 - Excavation, debris screening, solidification/stabilization, and off-site disposal (Subtitle D)
- Alternative 8 - Excavation, debris screening, soil washing, backfill of clean soil, off-site encapsulation and disposal of contaminated soil (Subtitle C), and off-site disposal of debris (Subtitle D)

These eight alternatives were evaluated based on their effectiveness, implementability, and cost.

RECOMMENDED ALTERNATIVE

Based on the comparative analyses of removal action alternatives conducted as part of this EE/CA, Alternative 5, consolidation and containment, was identified as the recommended alternative for the 12th Street Landfill/Dump Site. Under this alternative, contaminated material outside of the current boundaries of the soil cap installed during the April 2000 time-critical removal action would be consolidated into the area south of 12th Street. This area would then be covered with a low-permeability, engineered cover and contained with a slurry wall vertical barrier encircling the site.

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1.0 INTRODUCTION

1.1 PROJECT AUTHORIZATION

Under the Eastern Area Superfund Technical Assessment and Response Team (START) contract, the U.S. Environmental Protection Agency (EPA) tasked Tetra Tech EM Inc. (Tetra Tech) to draft an engineering evaluation/cost analysis (EE/CA) under technical directive document (TDD) No. 03-00-11-002. This EE/CA evaluates and summarizes current site conditions (post time-critical removal action), presents and evaluates removal action alternatives (RAAs), and recommends an alternative for a non time-critical removal action for the 12th Street Landfill/Dump Site in Wilmington, Delaware (see Figure 1). Figures discussed in this EE/CA are included at the end of the text of this document. This work is being performed in accordance with the response program identified in the National Oil and Hazardous Substances Contingency Plan (NCP), 40 Code of Federal Regulations (CFR) Part 300. In addition, this EE/CA was prepared according to EPA's guidance regarding non time-critical removal actions under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) (1993).

1.2 OBJECTIVE AND SCOPE

The primary objective of this EE/CA is to evaluate available alternatives to prevent the migration of hazardous substances from the 12th Street Landfill/Dump Site and related areas of contamination into Brandywine Creek, which pose a significant threat to human health or the environment. Additionally, alternatives designed to mitigate potential threats to humans through direct contact with site contaminants were also evaluated. Finally, this EE/CA also serves to provide an analysis of existing site conditions following completion of an EPA time-critical removal action at the site (installation of a soil cap, along with erosion and sedimentation controls).

1.3 SITE BACKGROUND

In June 1999, the Delaware Department of Natural Resources and Environmental Control (DNREC) conducted an assessment of the 12th Street Landfill/Dump Site as part of a Brownfield Preliminary Assessment (BPA) targeted at properties along the eastern bank of Brandywine Creek, near 12th Street, in Wilmington, Delaware. Based on data generated during this assessment, EPA was notified and requested to conduct additional investigations (DNREC 2000b).

In August 1999, EPA conducted a sampling assessment at the 12th Street Landfill/Dump Site in conjunction with DNREC (Roy F. Weston [Weston] 2000). Analytical results indicated the presence of elevated concentrations of lead (up to 264,000 milligrams per kilogram [mg/kg]) in soil at the site. In April 2000, EPA initiated a time-critical removal action at the site designed to address immediate concerns regarding erosion of the bank along Brandywine Creek and the potential migration of hazardous substances present in site soil into Brandywine Creek. Analytical data for sediment samples collected from Brandywine Creek along the site boundary have indicated that the concentrations of contaminants associated with the site are present at levels that pose a potentially adverse threat to biological receptors. Activities conducted under the time-critical removal action were intended to prevent migration of additional contaminants into Brandywine Creek and included the clearing of vegetation from the site, the stabilization and grading of both the bank along Brandywine Creek and exposed contaminated site soil, installation of a 2-foot soil cap over the site, and the revegetation of the site. As the time-critical removal action progressed, the boundaries of the site expanded, based on analytical data and analysis of historical aerial photographs. Based on recent analytical data, lead-contaminated soil has been identified outside of the current extent of the soil cap installed under the time-critical removal action (that is, north of 12th Street, on the western side of Shellpot Creek) (EPA 2000c).

2.0 SITE CHARACTERIZATION

2.1 SITE DESCRIPTION

This section describes the site location and history, structure and topography, geology, hydrogeology, surface water, surrounding land use and populations, sensitive ecosystems, and meteorology associated with the 12th Street Landfill/Dump Site.

2.1.1 Site Location and History

The 12th Street Landfill/Dump Site is located near the eastern edge of Wilmington, Delaware, near the 12th Street entrance and exit ramps to Interstate 495. The site is situated along the eastern bank of Brandywine Creek, a tidally influenced water body that empties into the Christina River approximately 0.75-mile south of the site (EPA 1999a). The property is bordered to the west by Brandywine Creek, to the northwest by an industrial property, to the east by 12th Street and a Norfolk Southern railroad right-of-way, and to the south by open land, including some wetlands. The boundaries of the area of contamination have recently expanded as a result of analytical data received for various samples collected during the course of the time-critical removal action, which was initiated in April 2000 to address immediate concerns related to the eroding bank of Brandywine Creek and the potential for migration of contaminants (EPA 2000c).

The area encompassed by the 12th Street Landfill/Dump Site and related areas of contamination consists of at least five separate tax parcels: three parcels are located south of 12th Street, and two parcels are located north of 12th Street. In the area to the south of 12th Street, the western parcel located adjacent to Brandywine Creek is deeded to the Wilmington Economic Development Corporation, while the eastern parcel is deeded to the state of Delaware Department of Transportation; the parcel located at the northern end of this area is owned by a private citizen (EPA 2000c). Based on historical aerial photographs, portions of the past waste disposal activities also extend beneath and north of 12th Street; affected tax parcels in this area are deeded to the State of Delaware Department of Corrections (Gander Hill Prison) and the Norfolk Southern Railroad Company (EPA 1999a).

Past history at the site has reportedly involved the operation of the Electric Hose and Rubber Company, which formerly manufactured rubber hoses for a variety of industrial uses in the facility buildings located at the northern end of the site. Apparently, waste hoses and lead castings used in the manufacturing process were disposed in the area now known as the 12th Street Landfill/Dump Site. Based on review of available aerial photographs for the area, the main period of waste disposal activity at the site appears to have begun sometime prior to 1950 and continued until sometime between 1968 and 1977 (EPA 2000c).

2.1.2 Structure and Topography

The 12th Street Landfill/Dump Site is located along the eastern bank of Brandywine Creek and consists of a gently sloped property, with a drainage swale running the length of the approximate center of the site, roughly from north to south. Surface runoff is generally channeled through this drainage swale toward the southern end of the site, where it discharges to Brandywine Creek. Elevations at the site range from sea level adjacent to Brandywine Creek to approximately 15 feet above mean sea level (msl) at the top of the bank and in the center of the site. At the northern end of the site along Brandywine Creek stands a series of buildings, which formerly housed the Electric Hose and Rubber Company facility. The majority of this building space is currently used for warehouse and storage space (Brandywine Industrial Complex), while the southern portion is used in operations associated with an equipment storage and recycling facility (Asset Recovery Services, Inc.) (EPA 2000c).

2.1.3 Geology

The 12th Street Landfill/Dump Site is situated along the eastern bank of Brandywine Creek, near the outskirts of Wilmington, New Castle County, Delaware. Elevations at the site range from sea level to approximately 15 feet above msl. The geology of this region is characterized by severe metamorphic processes and crustal upheavals, which also resulted in the formation of the Appalachian Mountains. Surficial geology of this region is dominated by deposits of the Pleistocene Age Columbia Formation, which consists primarily of orange, tan, and yellow, medium to coarse sands and gravels. These sediments were reportedly deposited by Pleistocene Age streams, which formed a series of channels in New Castle County. In the vicinity of the 12th Street Landfill/Dump Site, these sediments are of minimal thickness and are absent in many areas of northern Delaware (Sundstrom and Pickett 1971).

New Castle County encompasses portions of two regional geologic provinces: the Appalachian Piedmont (Piedmont) and the Atlantic Coastal Plain (Coastal Plain) Provinces. The northernmost part of the county lies in the Piedmont, a complex of very old metamorphic and igneous rocks, which slopes down toward the Delaware River to the east. In the southern portion of the county, the Piedmont forms a base upon which the Coastal Plain lies as a landward extension of the Atlantic Continental Shelf. The Coastal Plain is a wedge-shaped mass of sedimentary rock sitting atop the Piedmont and consists primarily of unconsolidated clays, silts, sands, and gravels that reach a thickness of more than 2,300 feet in the southeastern portion of the county. The 12th Street Landfill/Dump Site is situated near the physiographic border of the Piedmont and Coastal Plain; this boundary is termed the fall zone (Sundstrom and Pickett 1971).

The Piedmont consists primarily of crystalline rocks of complex metamorphic and igneous origin. Rocks associated with the Piedmont are divided into the Glenarm Series and the Wilmington Complex. The Glenarm Series is subdivided into the Cockeysville Marble and the Wissahickon Formation. The Wissahickon Formation is a biotite-quartz-plagioclase feldspar schist with migmatite zones; the formation generally strikes northeast and dips to the southeast. The Cockeysville Marble consists of granular, friable marble seen as outcrops in only a few areas of the county. The Wilmington Complex, a dense gray rock that is occasionally banded, is subdivided into amphibolites, gabbros, banded gneisses, and some granite. Bedrock at the site consists of metaigneous and metasedimentary rocks of the Wilmington Complex; these rocks are composed primarily of hypersthene-quartz-andesine gneiss, with minor amounts of biotite and magnetite. Regolith overlying the bedrock in the vicinity of the site reportedly varies from 0 to 20 feet in thickness. As the Piedmont slopes down to the east, these crystalline rocks form the base upon which the Coastal Plain sets (Sundstrom and Pickett 1971).

In the vicinity of the 12th Street Landfill/Dump Site, the primary formation associated with the Coastal Plain is the Potomac Formation, which consists of variegated red, gray, purple, yellow, and white lignitic silts and clays, containing interbedded white, gray, and rust-brown quartz sands and some gravel. The thickness of this formation increases in a southeasterly direction, from zero in the northern portion of the county, to more than 1,300 feet in the southeastern portion of the county (Sundstrom and Pickett 1971).

2.1.4 Hydrogeology

Groundwater in the vicinity of the 12th Street Landfill/Dump Site occurs in the Pleistocene/Columbia Formation as well as both the Piedmont and Coastal Plain Provinces. Locally, groundwater discharges to Brandywine Creek as seeps migrating through the subsurface; statistics indicate that groundwater discharges account for nearly 67 percent of the base flow of nearby streams, including Brandywine Creek. Groundwater beneath the site has been found to be present at extremely shallow depths within 10 feet below ground surface, and seeps were found to be discharging from the bank of Brandywine Creek during the time-critical removal action (Sundstrom and Pickett 1971).

In the Piedmont Province, groundwater is present primarily in areas where weathering or fracturing of the igneous gabbros has taken place; the very old rocks of the Piedmont Province are relatively impermeable, and therefore yield only limited quantities of water. In the Coastal Plain Province present in the vicinity of the 12th Street Landfill/Dump Site, groundwater occurs primarily in the Potomac Formation (Sundstrom and Pickett 1971).

2.1.5 Surface Water

The primary surface water body associated with the 12th Street Landfill/Dump Site is Brandywine Creek, a tidally influenced water body, which flows adjacent to the western boundary of the site and empties into the Christina River, approximately 0.75-mile south of the site; the Christina River then discharges to the Delaware River, approximately 2 miles downstream of the site. Both groundwater migrating through the site and surface water runoff from the site drain into Brandywine Creek. Mean high tide at the site is estimated to be approximately 5.\5 feet above msl, and the site is subject to regular tidal flushing (EPA 2000c). Mean annual discharge rates associated with Brandywine Creek, the Christina River, and the Delaware River are 496 cubic feet per second (cfs), 678.6 cfs, and 11,744 cfs, respectively (DNREC 2000b). In addition, the 12th Street Landfill/Dump Site is situated within the boundaries of the 100-year flood plain (Federal Emergency Management Agency 2000).

Surface water runoff from the site is channeled into a drainage swale, which runs generally north to south through the site; this swale channels water into Brandywine Creek, near the southern boundary of the site. In addition, a drainage ditch is present along the Norfolk Southern rail line which borders the site to the east; runoff entering the northern end of this ditch is drained through an 8-inch, polyvinyl chloride pipe, installed during the time-critical removal action, to drain water from the ditch into Brandywine Creek, rather than allowing the water to migrate through the landfill/dump materials (EPA 2000c).

2.1.6 Surrounding Land Use and Populations

The 12th Street Landfill/Dump Site is located in a moderately industrialized section of Wilmington, Delaware. Bordering the site to the north is an operation involving the storage and recycling of stainless-steel food-grade equipment (Asset Recovery Services, Inc.), while a railroad right-of-way, 12th Street, and a cement manufacturing operation are located along the eastern edge of the site. Other land use present in the immediate vicinity of the site includes a prison operated by the State of Delaware Department of Corrections (approximately 0.25-mile northeast of the site), Interstate 495 (less than 0.25-mile east of the site), and a sewage treatment plant located just on the eastern side of Interstate 495 (approximately 0.5-mile from the site). The site is also bordered to the south and east by wetlands, while Brandywine Creek flows adjacent to the western edge of the site. No residential populations are present in the immediate vicinity of the site (EPA 2000c).

2.1.7 Sensitive Ecosystems

According to the Delaware Natural Heritage Inventory, federally endangered species found in the vicinity of the site include the peregrine falcon (a nesting area is present on the Delaware Memorial Bridge, and they use the surrounding area to obtain food) and the short-nosed sturgeon (known to spawn in the Delaware River and its tributaries, including the Christina River). The Bur-marigold, a candidate plant species for the federally endangered species list, has also been identified in the vicinity of the site. In addition, the following plant species have been identified as endangered within the state of Delaware, and are present along the Christina River, across from its confluence with Brandywine Creek: arrowhead, horned pondweed, and Engelmann umbrella sedge. Brandywine Creek is home to a variety of fish species, including perch, small-mouth bass, shad (seasonal), catfish, and carp. In addition, both tidal and non tidal wetlands have been identified along Brandywine Creek (DNREC 2000a, 2000b).

2.1.8 Meteorology

The climate associated with Wilmington, Delaware, is relatively moderate. The average annual temperature in Wilmington is 54.6 degrees Farenheit (°F) while average monthly temperatures range from 35 °F in January up to 76 °F in July. Average annual precipitation is approximately 44.38, inches while average monthly precipitation ranges from 2.72 inches in February to 5.34 inches in August. A 2-year, 24-hour rainfall event would produce approximately 3.3 inches of rain (DNREC 2000b).

2.2 PREVIOUS REMOVAL ACTIONS AND INVESTIGATIONS

This section describes past investigations and assessments associated with the 12th Street Landfill/Dump Site that have been conducted by various agencies and organizations.

2.2.1 June 1999 Brownfields Site Assessment

In June 1999, DNREC conducted a BPA for the Diamond State Foundry/Pullman Palace Car Works, which included the collection of various environmental samples from properties along the eastern bank of Brandywine Creek in Wilmington, Delaware. As part of the BPA, DNREC collected samples from the area adjacent to the former Electric Hose & Rubber Company facility and now identified as the 12th Street Landfill/Dump Site. In addition, the BPA also identified numerous exposed drums along the actively eroding bank of Brandywine Creek. Analytical data from the BPA indicated the presence of metals, including arsenic (up to 72.4 mg/kg), chromium (up to 317 mg/kg), and lead (up to 41,900 mg/kg) at concentrations exceeding EPA Region 3 risk-based concentrations (RBCs). Subsequently, DNREC requested EPA assistance to investigate what appeared to be drums at the site containing hazardous substances (DNREC 2000b).

2.2.2 August/September 1999 Removal Assessment

Between August 26 and September 2, 1999, EPA initiated a removal assessment at the 12th Street Landfill/Dump Site. The removal assessment included the collection of six surface soil samples, three subsurface soil samples, two sediment samples, one groundwater sample, four samples from ash-like material present at the site, and four samples from drum contents at the site. The removal assessment also involved the excavation of test pits in various areas of the site (Weston 2000).

Analytical data generated from the removal assessment documented soil contaminated with arsenic (up to 117 mg/kg), and lead (up to 264,000 mg/kg) at levels exceeding EPA Region 3 RBCs. In addition, the assessment also showed groundwater to be contaminated with arsenic (up to 0.0052 milligrams per liter [mg/L]) at levels above RBCs (Weston 2000).

2.2.3 January 2000 Risk Assessment Sampling

In January 2000, EPA conducted additional sampling at the 12th Street Landfill/Dump Site in support of an ecological risk assessment planned for the site. The risk assessment sampling included the collection of 28 surface soil samples, 9 subsurface soil samples, and 54 sediment samples (Weston 2000).

Analytical data generated from the risk assessment sampling confirmed the presence of soil contaminated with arsenic (up to 114 mg/kg) and lead (up to 73,000 mg/kg) at concentrations exceeding RBCs and available guidance levels. In addition, biotoxicity testing, using soil samples obtained from the site and earthworms (*eisenia foetida*), revealed reduced survival rates (72 percent) in comparison to laboratory control samples (93 percent) (Weston 2000).

Sediment samples collected from Brandywine Creek, along the western boundary of the site, indicated only low concentrations of contaminants associated with the site (that is, present at concentrations below guidance levels). However, four "hotspot" locations were determined to contain elevated concentrations of contaminants (for example, lead at concentrations up to 19,500 mg/kg); these locations were addressed during excavation operations conducted under the April 2000 time-critical removal action because they posed a threat to aquatic receptors (Weston 2000).

2.2.4 Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Time-Critical Removal Action Sampling

In April 2000, EPA initiated a time-critical removal action at the 12th Street Landfill/Dump Site to address immediate threats posed by the active erosion of the bank along Brandywine Creek and the potential migration of contaminants into Brandywine Creek; these threats are described in detail in the Action Memorandum, which was approved by EPA on March 10, 2000 (EPA 2000b). Periodic sampling was conducted during the removal action to further characterize and delineate the boundaries of contaminants at the site. This sampling has included the collection of soil, sediment, surface water, and groundwater samples from various areas on and around the site (EPA 2000c).

Analytical data generated from sampling conducted during the CERCLA time-critical removal action confirmed the presence of elevated concentrations of lead in soil in areas currently covered by the soil cap (EPA 2000c). In addition, data have documented the presence of high concentrations of lead (up to 50,100 mg/kg) in soil located outside of the boundaries of the current soil cap installed during the time-critical removal action; this area is located just north of 12th Street, on property owned by the State of Delaware Department of Corrections (Gander Hill Prison) and the Norfolk Southern Railroad Company (Tetra Tech 2001). Based on historical aerial photographs, this contamination is likely associated with past waste disposal practices at the former Electric Hose and Rubber Company facility (EPA 1999a).

2.3 SOURCE, NATURE, AND EXTENT OF CONTAMINATION

This section describes the extent of contamination associated with the 12th Street Landfill/Dump Site and provides summary tables for analytical data generated at the site.

2.3.1 Extent of Contamination

Both arsenic and lead have been identified as contaminants of concern at the 12th Street Landfill/Dump Site and related areas of contamination (north of 12th Street along Shellpot Creek). The compound bis(2-ethylhexyl)phthalate has also been identified in samples collected from the site and is likely attributable to the large quantities of rubber hose contained within the landfill; however, it is present at concentrations below RBCs and therefore has not been a governing factor in determining removal actions for the site. Analytical data indicate that lead concentrations in soil exceeding available guidance levels are present throughout the site at varying depths (EPA 1989b, 1994, 2000c). In addition, the presence of debris (including scrap metal, industrial hoses, and old wooden pilings), believed to be a source of contamination, has also been documented throughout the site. To date, a 2-foot soil cap has been installed at the site in the area south of 12th Street to cover areas known to contain debris or elevated concentrations of contaminants. Figure 2 shows the approximate boundaries of the soil cap installed during the time-critical removal action (EPA 2000c).

2.3.2 Analytical Data Summary

Table 2-1 presents a summary of analytical data described in the previous sections. Sampling locations are illustrated on Figure 3.

TABLE 2-1

ANALYTICAL SUMMARY – ARSENIC AND LEAD

Sample ID	Location	Depth	Date	Arsenic	Lead
Waste Material Samples (mg/kg)					
TS-AM-01	Ash-like material along bank of Brandywine Creek	0-6 inches	8/31/99	8.9	593
TS-AM-02	Ash-like material beneath cluster of drums along bank of Brandywine Creek	0-6 inches	8/31/99	26	383
TS-AM-03	Ash-like material collected from test pit #1 in northern section of site	5-6 feet bgs	8/31/99	13.1	2,570
TS-FD-03	Duplicate of TS-AM-03	5-6 feet bgs	8/31/99	26.4	911
TS-DC-01	Exposed drum along bank of Brandywine Creek; rubber substance	Not applicable	9/1/99	5.1	207
TS-DC-02	Drum contents discovered in Test Pit #2 in the central section of site	7 feet bgs	9/1/99	15.3	106,000
TS-DC-03	Exposed drum along drainage ditch	Not applicable	9/1/99	ND	ND

TABLE 2-1 (Continued)

ANALYTICAL SUMMARY – ARSENIC AND LEAD

Sample ID	Location	Depth	Date	Arsenic	Lead
Waste Material Samples (mg/kg) (Continued)					
TS-DC-04	Drum contents discovered in a test pit along bank of Brandywine Creek	4 feet bgs	9/1/99	19.7	3,970
Surface Soil Samples (mg/kg)					
TS-SS-01	Along creek bank near exposed drum in central section of site	0-6 inches	8/31/99	33.6 (K)	206,000 (J)
TS-SS-02	Along creek bank in central section of site	0-6 inches	8/31/99	48.8 (K)	139,000 (J)
TS-SS-03	Near center of site	0-6 inches	8/31/99	117 (K)	7,460 (J)
TS-SS-04	Drainage channel in southern section of site	0-6 inches	8/31/99	24 (K)	11,100 (J)
TS-SS-05	Near exposed drum in southern section of site	0-6 inches	8/31/99	96.3 (K)	4,590 (J)
TS-FD-01	Duplicate sample of TS-SS-05	0-6 inches	8/31/99	96.9 (K)	5,630 (J)
TS-SS-06	Along creek bank in northern section of site	0-6 inches	1/11/00	NA	2,869 [a]
TS-SS-07	Along creek bank in northern section of site	0-6 inches	1/11/00	NA	1,955 [a]
TS-SS-08	Along creek bank in northern section of site	0-6 inches	1/11/00	107	6,890 (J)
TS-SS-09	Along creek bank in northern section of site	0-6 inches	1/11/00	50.2	33,500 (J)
TS-SS-10	Along creek bank in central section of site	0-6 inches	1/11/00	86.5	9,330 (J)
TS-SS-11	Along creek bank in central section of site	0-6 inches	1/11/00	NA	2,333 [a]
TS-SS-12	Along creek bank in central section of site	0-6 inches	1/11/00	23.5	7,780 (J)
TS-SS-13	Top of creek bank in northern section of site	0-6 inches	1/12/00	47.7	3,660
TS-SS-14	Top of creek bank in northern section of site	0-6 inches	1/12/00	NA	1,330 [a]
TS-SS-15	Top of creek bank in central section of site	0-6 inches	1/12/00	86.9	1,690
TS-SS-16	Top of creek bank in central section of site	0-6 inches	1/12/00	NA	2,970 [a]
TS-SS-17	Top of creek bank in central section of site	0-6 inches	1/12/00	105	7,790
TS-SS-18	Central section of site	0-6 inches	1/12/00	93.7	3,970
TS-SS-19	Top of creek bank in central section of site	0-6 inches	1/12/00	NA	3,480 [a]
TS-SS-20	Top of creek bank in central section of site	0-6 inches	1/12/00	NA	3,140 [a]
TS-SS-21	Central section of site	0-6 inches	1/12/00	83.6	2,400
TS-SS-22	Top of creek bank in northern section of site	0-6 inches	1/12/00	NA	7,140 [a]
TS-SS-23	Top of creek bank in northern section of site	0-6 inches	1/12/00	NA	2,660 [a]
TS-SS-24	Central section of site	0-6 inches	1/12/00	12.2	521
TS-SS-25	Central section of site	0-6 inches	1/12/00	NA	3,254 [a]
TS-SS-26	Central section of site	0-6 inches	1/12/00	NA	225 [a]
TS-SS-27	Central section of site	0-6 inches	1/12/00	NA	716 [a]
TS-SS-28	Northern section of site	0-6 inches	1/12/00	NA	1,150 [a]
TS-SS-29	Southern section of site	0-6 inches	1/12/00	NA	75.2 [a]
TS-SS-30	Southern section of site	0-6 inches	1/13/00	NA	43.6 [a]
TS-SS-31	Southern section of site	0-6 inches	1/13/00	NA	297 [a]
TS-SS-32	Southern section of site	0-6 inches	1/13/00	NA	35.4 [a]
TS-SS-33	Southern section of site	0-6 inches	1/13/00	NA	232 [a]
TS-SS-34	Top of creek bank in central section of site	0-12 inches	1/13/00	73.9	7,350
TS-SS-35	Top of creek bank in central section of site	0-12 inches	1/13/00	114	13,400
TS-SS-36	Creek bank in central section of site	0-12 inches	1/13/00	18.9	22,600
TS-SS-37	Northern section of site	0-12 inches	1/13/00	17.4	566
NS-1	North of 12th Street; west of Shellpot Creek (Norfolk Southern property)	0-6 inches	2/13/01	26.9	5,340

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TABLE 2-1 (Continued)

ANALYTICAL SUMMARY – ARSENIC AND LEAD

Sample ID	Location	Depth	Date	Arsenic	Lead
Surface Soil Samples (mg/kg) (Continued)					
NS-2	North of 12th Street; west of Shellpot Creek (Norfolk Southern property)	0-6 inches	2/13/01	18.9	50,100
NS-3	North of 12th Street; west of Shellpot Creek (Norfolk Southern property)	0-6 inches	2/13/01	12.5	366
NS-4	North of 12th Street; west of Shellpot Creek (Norfolk Southern property)	0-6 inches	2/13/01	24.3	716
NS-5	North of 12th Street; west of Shellpot Creek (Norfolk Southern property)	0-6 inches	2/13/01	17.2	3,710
NS-6	North of 12th Street; west of Shellpot Creek (Norfolk Southern property)	0-6 inches	2/13/01	35.4	1,880
NS-7	South of 12th Street outside entrance gate to ARS Inc facility; between fenceline and Norfolk Southern rail line	0-6 inches	2/13/01	25.6	5,200
GH-8	North of 12th Street on Gander Hill Prison property; "right field" of the baseball field	0-6 inches	2/13/01	9.4	743
GH-9	North of 12th Street on Gander Hill Prison property; "right field" of the baseball field	0-6 inches	2/13/01	8.2	658
GH-10	North of 12th Street on Gander Hill Prison property; "right field" of the baseball field	0-6 inches	2/13/01	7.9	7,930
TS-SB-01	Test Pit #1 in the northern section of the site	10 feet bgs	8/31/99	16.2 (K)	7,670 (J)
TS-SB-02	Test Pit #2 in the northern section of the site	6.5-7 feet bgs	9/1/99	29.4 (K)	264,000 (J)
TS-SB-03	Test Pit #4 in the southern section of the site	7 feet bgs	9/1/99	27.8 (K)	ND
TS-SB-04	Top of creek bank in central section of site	3-3.5 feet bgs	1/13/00	NA	5,140 [a]
TS-SB-05	TS-SS-15	2.5-3 feet bgs	1/13/00	NA	2,980 [a]
TS-SB-06	Top of creek bank in northern section of site	3-3.5 feet bgs	1/13/00	NA	1,375 [a]
TS-SB-07	Top of creek bank in northern section of site	2.5-3 feet bgs	1/13/00	NA	5,350 [a]
TS-SB-08	Central section of site	2.5-3 feet bgs	1/13/00	NA	7,760 [a]
TS-SB-09	Top of creek bank in central section of site	3-3.5 feet bgs	1/13/00	NA	13,889 [a]
TS-SB-10	Central section of site	3-3.5 feet bgs	1/13/00	NA	5,012 [a]
TS-SB-11	Top of creek bank in northern section of site	3-3.5 feet bgs	1/13/00	NA	28,600 [a]
TS-SB-12	Northern section of site	2.5-3 feet bgs	1/13/00	NA	98.3 [a]
T1-TP-04	Test Pit #1 (southeastern section of site)	4 feet bgs	6/30/00	11.6	4,020
TP-08	Test Pit #8 (eastern central section of site)	5 feet bgs	7/7/00	328	1,200
TP-09	Test Pit #9 (eastern central section of site)	4-6 feet bgs	7/7/00	394	991
TP-WP-07	Test Pit #7 (eastern central section of site)	3-4 feet bgs	7/7/00	10	72.2
TPG-07	Test Pit #7 (eastern central section of site)	3-4 feet bgs	7/7/00	2.3 (K)	21.7
S-1	Test Pit in northern section of site	2 feet bgs	11/6/00	ND	65,700
S-2	Test Pit in northern section of site	3 feet bgs	11/6/00	ND	29,600
S-3	Test Pit in northern section of site	4 feet bgs	11/6/00	ND	31,200
S-1	Adjacent to sea wall approximately 50 feet north of its southern end	2-3 feet bgs	12/19/00	6.5	202
S-2	Adjacent to sea wall approximately 25 feet north of its southern end	1.5 feet bgs	12/19/00	8.1	115

TABLE 2-1 (Continued)

ANALYTICAL SUMMARY – ARSENIC AND LEAD

Sample ID	Location	Depth	Date	Arsenic	Lead
Background Soil Samples (mg/kg)					
TS-BG-01	Brandywine Creek mudflat adjacent to Brandywine Creek Park (Wilmington, DE)	0-6 inches	1/13/00	3.4 (K)	31.4
TS-BG-02	Brandywine Creek Park (Wilmington, DE)	0-6 inches	1/13/00	8.5	174
TS-BG-03	Brandywine Creek Park (Wilmington, DE)	2-2.5 feet bgs	1/13/00	5.3	75.2
TS-BG-04	Top of creek bank in southern section of site	0-12 inches	2/14/00	13.8	29.2
Groundwater Samples (µg/L)					
TS-TP-03W	Test pit #3 in the central section of the site	Not applicable	9/1/99	5.2	ND
GP-1	Northern section of site	Not applicable	7/31/00	ND	ND
GP-2	Southeastern section of site	Not applicable	7/31/00	22	ND
GP-3	Northeastern section of site	Not applicable	7/31/00	ND	ND
GP-4	Northwestern section of site	Not applicable	7/31/00	ND	ND
GP-5	Southwestern section of site	Not applicable	7/31/00	ND	ND
GP-6	Southwestern section of site	Not applicable	7/31/00	ND	ND
GP-1	Northern section of site	Not applicable	9/00	ND	82
GP-2	Southeastern section of site	Not applicable	9/00	ND	ND
GP-3	Northeastern section of site	Not applicable	9/00	ND	ND
GP-3	Northeastern section of site (dissolved analyses)	Not applicable	9/00	ND	ND
GP-4	Northwestern section of site	Not applicable	9/00	ND	ND
GP-5	Southwestern section of site	Not applicable	9/00	ND	8
GP-6	Southwestern section of site	Not applicable	9/00	ND	ND
Sediment Samples (mg/kg)					
TS-SED-01	Mudflat along eastern bank of Brandywine Creek	0-6 inches	8/31/99	15.7 (K)	8,370 (J)
TS-SED-02	Mudflat along eastern bank of Brandywine Creek	0-6 inches	8/31/99	5.9 (K)	1,120 (J)
TS-SED-03	Mudflat along eastern bank of Brandywine Creek	0-6 inches	1/11/00	NA	188 [a]
TS-SED-04	Mudflat along eastern bank of Brandywine Creek	0-6 inches	1/11/00	NA	40 [a]
TS-SED-05	Mudflat along eastern bank of Brandywine Creek	0-6 inches	1/11/00	NA	1,134 [a]
TS-SED-05A	Mudflat along eastern bank of Brandywine Creek	6-7 inches	2/22/00	NA	1,520 [a]
TS-SED-05B	Mudflat along eastern bank of Brandywine Creek	12-13 inches	2/22/00	NA	720 [a]
TS-SED-06	Mudflat along eastern bank of Brandywine Creek	0-6 inches	1/11/00	NA	48 [a]
TS-SED-07	Mudflat along eastern bank of Brandywine Creek	0-6 inches	1/11/00	23	19,500 (J)
TS-SED-07A	Mudflat along eastern bank of Brandywine Creek	11-12 inches	2/22/00	NA	6,660 [a]
TS-SED-07B	Mudflat along eastern bank of Brandywine Creek	5-6 inches	2/22/00	NA	192 [a]
TS-SED-08	Mudflat along eastern bank of Brandywine Creek	0-6 inches	1/11/00	NA	1,210 [a]
TS-SED-08A	Mudflat along eastern bank of Brandywine Creek	6-7 inches	2/22/00	NA	18.5 [a]
TS-SED-08B	Mudflat along eastern bank of Brandywine Creek	11-13 inches	2/22/00	NA	25.6 [a]
TS-SED-09	Mudflat along eastern bank of Brandywine Creek	0-6 inches	1/11/00	NA	690 [a]
TS-SED-09A	Mudflat along eastern bank of Brandywine Creek	5-7 inches	2/22/00	NA	166 [a]
TS-SED-09B	Mudflat along eastern bank of Brandywine Creek	11-13 inches	2/22/00	NA	272 [a]
TS-SED-10	Mudflat along eastern bank of Brandywine Creek	0-6 inches	1/11/00	9.5	277 (J)
TS-SED-11	Mudflat along eastern bank of Brandywine Creek	0-6 inches	1/11/00	62.1	508 (J)
TS-SED-11A	Mudflat along eastern bank of Brandywine Creek	6-7 inches	2/22/00	NA	20.4 [a]
TS-SED-11B	Mudflat along eastern bank of Brandywine Creek	11-13 inches	2/22/00	NA	256 [a]
TS-SED-12	Mudflat along eastern bank of Brandywine Creek	0-6 inches	1/12/00	NA	53.8 [a]
TS-SED-13	Mudflat along eastern bank of Brandywine Creek	0-6 inches	1/11/00	NA	135 [a]

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TABLE 2-1 (Continued)

ANALYTICAL SUMMARY – ARSENIC AND LEAD

Sample ID	Location	Depth	Date	Arsenic	Lead
Sediment Samples (mg/kg) (Continued)					
TS-SED-14	Mudflat along eastern bank of Brandywine Creek	0-6 inches	1/12/00	4.6	14.9 (J)
TS-SED-15	Mudflat along eastern bank of Brandywine Creek	0-6 inches	1/11/00	6.7	181 (J)
TS-SED-15A	Mudflat along eastern bank of Brandywine Creek	5-7 inches	2/22/00	NA	16.3 [a]
TS-SED-15B	Mudflat along eastern bank of Brandywine Creek	11-13 inches	2/22/00	NA	37.7 [a]
TS-SED-16	Mudflat along eastern bank of Brandywine Creek	0-6 inches	1/11/00	NA	17.6 [a]
TS-SED-17	Mudflat along eastern bank of Brandywine Creek	0-6 inches	1/11/00	9.7	461 (J)
TS-SED-18	Mudflat along eastern bank of Brandywine Creek	0-6 inches	1/12/00	29.2	5,620 (J)
TS-SED-18A	Mudflat along eastern bank of Brandywine Creek	5-7 inches	2/22/00	NA	176 [a]
TS-SED-18B	Mudflat along eastern bank of Brandywine Creek	11-13 inches	2/22/00	NA	49.5 [a]
TS-SED-19	Mudflat along eastern bank of Brandywine Creek	0-6 inches	1/12/00	4.7	21.6 (J)
TS-SED-20	Mudflat along eastern bank of Brandywine Creek	0-6 inches	1/12/00	NA	33.9 [a]
TS-SED-21	Mudflat along eastern bank of Brandywine Creek	0-6 inches	1/12/00	NA	55.7 [a]
TS-SED-22	Mudflat along eastern bank of Brandywine Creek	0-6 inches	1/12/00	NA	96.3 [a]
TS-SED-23	Mudflat along eastern bank of Brandywine Creek	0-6 inches	1/12/00	56.9	3,170 (J)
TS-SED-23A	Mudflat along eastern bank of Brandywine Creek	5-7 inches	2/22/00	NA	28.8 [a]
TS-SED-23B	Mudflat along eastern bank of Brandywine Creek	11-13 inches	2/22/00	NA	21 [a]
TS-SED-24	Mudflat along eastern bank of Brandywine Creek	0-6 inches	1/12/00	NA	463 [a]
TS-SED-24A	Mudflat along eastern bank of Brandywine Creek	5-7 inches	2/22/00	NA	104 [a]
TS-SED-24B	Mudflat along eastern bank of Brandywine Creek	11-13 inches	2/22/00	NA	80.4 [a]
TS-SED-25	Mudflat along eastern bank of Brandywine Creek	0-6 inches	1/12/00	NA	2,420 [a]
TS-SED-25A	Mudflat along eastern bank of Brandywine Creek	5-7 inches	2/22/00	NA	978 [a]
TS-SED-25B	Mudflat along eastern bank of Brandywine Creek	11-13 inches	2/22/00	NA	18.7 [a]
TS-SED-26	Mudflat along eastern bank of Brandywine Creek	0-6 inches	1/12/00	NA	387 [a]
TS-SED-27	Mudflat along eastern bank of Brandywine Creek	0-6 inches	1/12/00	11	36.6 (J)
TS-SED-28	Mudflat along eastern bank of Brandywine Creek	0-6 inches	1/12/00	9.7	29.2 (J)
TS-SED-29	Mudflat along eastern bank of Brandywine Creek	0-6 inches	1/12/00	9.2	26.5 (J)
TS-SED-30	Mudflat along eastern bank of Brandywine Creek	0-6 inches	1/12/00	NA	24.5 [a]
TS-SED-31	Mudflat along eastern bank of Brandywine Creek	0-6 inches	1/12/00	NA	20.2 [a]
TS-SED-32	Mudflat along eastern bank of Brandywine Creek	0-6 inches	1/12/00	NA	38.5 [a]
TS-SED-33	Mudflat along eastern bank of Brandywine Creek	0-6 inches	1/12/00	NA	22.9 [a]
TS-SED-34	Mudflat along eastern bank of Brandywine Creek	0-6 inches	1/12/00	NA	94.3 [a]
SD-1	Upstream background sample from western bank of Brandywine Creek, adjacent to railroad bridge	0-6 inches	2/15/01	6.9	179
SD-2	Upstream background sample from eastern bank of Brandywine Creek, approximately 100 yards upstream of railroad bridge	0-6 inches	2/15/01	4.7	96.8
SD-3	Downstream background sample from western bank of Brandywine Creek, directly across from weir/dam	0-6 inches	2/15/01	27.3	151
SD-4	Downstream background sample from east bank of Brandywine Creek approximately 100 yards downstream of dam/weir	0-6 inches	2/15/01	15.8	173
SD-5	Along sea wall, beneath a discharge pipe	0-6 inches	2/15/01	12.1	397
SD-6	Along sea wall, beneath a 12-inch discharge pipe	0-6 inches	2/15/01	4.6	169
SD-7	Mud flat along sea wall	0-6 inches	2/21/01	6	1,300

Sediment Samples (mg/kg) (Continued)					
SD-8	Mud flat along sea wall; duplicate of SD-7	0-6 inches	2/21/01	13.5	1,750
SD-9	Behind crumbling section of sea wall and beneath building foundation – appears to be creek sediment deposited during tidal events	0-6 inches	2/21/01	2.5	122
Disposal Samples (mg/kg)					
SC-01	Composite sample collected from soil pile for disposal analyses	Not applicable	11/00	30	1,700
Disposal Samples (mg/kg) (Continued)					
SC-02	Composite sample collected from soil pile for disposal analyses	Not applicable	11/00	17	56
Disposal Samples (TCLP results – mg/L)					
SC-01	Composite sample collected from soil pile for disposal analysis	Not applicable	11/00	ND	66
SC-02	Composite sample collected from soil pile for disposal analysis	Not applicable	11/00	ND	91

Notes:

a — Result obtained from DNREC x-ray fluorescence (XRF); where available, laboratory analytical data is included
bgs — Below ground surface
ID — Identification
J — Estimated result; actual value may not be accurate or precise
K — Biased result; actual value expected to be lower than reported
mg/kg — Milligrams per kilogram
NA — Not analyzed
ND — Not detected
TCLP — Toxicity Characteristic Leachate Procedure
µg/L — Micrograms per liter

2.3.3 Analytical Data Summary – Surface Water and Seep Samples

In addition to the analytical data described above, numerous aqueous samples were collected from Brandywine Creek and areas of seepage from the landfill/dump along the bank of Brandywine Creek (prior to installation of the soil cap). Table 2-2 provides a summary of the analytical data for these samples. Although the issue of seepage into Brandywine Creek has not been fully addressed by the time-critical removal action, the soil cap does reduce the infiltration of water into the landfill materials by promoting drainage through engineering controls; also, the drainage pipe installed from the ditch along the Norfolk Southern Railroad Company right-of-way to Brandywine Creek helps to prevent the migration of water through the landfill materials (this water previously drained directly through the landfill) (EPA 2000c).

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TABLE 2-2

ANALYTICAL SUMMARY – SURFACE WATER AND SEEP SAMPLES

Sample ID	Location	Depth	Date	Arsenic	Lead
Surface Water Samples (ug/L)					
BR-SW-01	Middle of Brandywine Creek	Not applicable	7/26/00	ND	2.4 (total) ND (dissolved)
P1	Sedimentation pond in southern section of site	Not applicable	7/26/00	5.4 (K) (total) 3.9 (K) (dissolved)	13.6 (total) ND (dissolved)
B-SW-01	Eastern edge of Brandywine Creek in southern section of site	Not applicable	7/26/00	ND	8 (total) ND (dissolved)
B-SW-02	Eastern edge of Brandywine Creek in central section of site	Not applicable	7/26/00	ND	9.8 (total) 2.3 (dissolved)
B-SW-03	Eastern edge of Brandywine Creek in central section of site	Not applicable	7/26/00	ND	20.6 (total) ND dissolved)
B-SW-04	Eastern edge of Brandywine Creek in northern section of site	Not applicable	7/26/00	ND	11.2 (total) ND (dissolved)
SW-1	Upstream background sample from western bank of Brandywine Creek, adjacent to railroad bridge	Not applicable	2/15/01	ND	ND
SW-2	Upstream background sample from eastern bank of Brandywine Creek, approximately 100 yards upstream of railroad bridge	Not applicable	2/15/01	ND	41.2
SW-3	Downstream background sample from western bank of Brandywine Creek, directly across from weir/dam	Not applicable	2/15/01	ND	ND
SW-4	Downstream background sample from eastern bank of Brandywine Creek, approximately 100 yards downstream of dam/weir	Not applicable	2/15/01	ND	40.5
SW-5	Along sea wall, beneath a discharge pipe	Not applicable	2/15/01	ND	ND
SW-6	Along sea wall, beneath a 12-inch discharge pipe	Not applicable	2/15/01	ND	ND
SW-7	Along sea wall from a 4-inch discharge pipe that is apparently draining from building	Not applicable	2/15/01	ND	13
SW-8	Eastern edge of Brandywine Creek along sea wall	Not applicable	2/21/01	ND	2.0 (J)
SW-9	Eastern edge of Brandywine Creek along sea wall; duplicate of SW-8	Not applicable	2/21/01	5.2	1.5 (J)
SW-10	Eastern edge of Brandywine Creek along sea wall	Not applicable	2/21/01	5.8	4.1
SW-1a	Eastern edge of Brandywine Creek near southern end of site	Not applicable	5/8/01	ND	4.4
SW-2a	Eastern edge of Brandywine Creek near south central portion of site	Not applicable	5/8/01	ND	1.1
SW-3a	Eastern edge of Brandywine Creek near northern end of site	Not applicable	5/8/01	ND	3.3

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TABLE 2-2 (Continued)

ANALYTICAL SUMMARY – SURFACE WATER AND SEEP SAMPLES

Sample ID	Location	Depth	Date	Arsenic	Lead
Surface Water Samples (ug/L) (Continued)					
SW-4a	Middle of Brandywine Creek	Not applicable	5/8/01	ND	ND
Seep Samples (µg/L)					
SL-1	Seep area emanating from creek bank in southern section of site	Not applicable	10/3/00	ND	309
SL-2	Seep area emanating from creek bank in southern section of site	Not applicable	10/3/00	29.8	24.8
SL-3	Seep area emanating from creek bank in southern section of site	Not applicable	10/3/00	241	1,780

Notes:

J Estimated result; actual value may not be accurate or precise
K Biased result; actual value expected to be lower than reported
ND Not detected
µg/L Micrograms per liter

Since the soil cap was installed and articulated concrete blocks (ACBs) were placed along the bank of Brandywine Creek, no significant seepage has been identified. In addition, analytical data suggests that the impact of elevated concentrations of lead contained in former seeps at the site on water quality in Brandywine Creek is limited (for example, concentrations of lead in surface water and sediment samples collected from Brandywine Creek are below national recommended water quality criteria and sediment screening guidelines (EPA 1999b, 2000c).

In addition to previous sampling conducted at the site, a surface water sampling plan has been prepared for the site and will include monthly sampling of surface water or seeps, if identified, in and along Brandywine Creek to document conditions and monitor for potential migration of contaminants from the landfill. This sampling was initiated in early May 2001; analytical results for the first round of sampling under this plan have been included in Table 2-2 (EPA 2000c).

2.3.4 Analytical Data Summary – bis(2-ethylhexyl)phthalate

In addition to laboratory detections of arsenic and lead, bis(2-ethylhexyl)phthalate, a semivolatile organic compound, has also been identified as a contaminant of concern at the 12th Street Landfill/Dump Site; it is likely attributable to the large quantities of waste rubber hoses found at the site. While bis(2-ethylhexyl)phthalate has been detected at notable concentrations, the detections are below RBCs for this compound, and as such, it has not been a governing factor in evaluating the non time-critical removal action. Table 2-3 provides a summary of analytical data for samples that were analyzed and determined to contain this substance (EPA 2000c).

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TABLE 2-3

ANALYTICAL SUMMARY – BIS(2-ETHYLHEXYL)PHTHALATE

Sample ID	Location	Depth	Date	Bis(2-ethylhexyl)-phthalate
Waste Material Samples (mg/kg)				
TS-AM-01	Ash-like material along bank of Brandywine Creek	0-6 inches	8/31/99	0.085 (J)
TS-AM-02	Ash-like material beneath cluster of drums along bank of Brandywine Creek	0-6 inches	8/31/99	0.13 (J)
TS-AM-03	Ash-like material collected from Test Pit #1 in northern section of site	5-6 feet bgs	8/31/99	0.079 (J)
TS-FD-03	Duplicate of TS-AM-03	5-6 feet bgs	8/31/99	0.81
TS-DC-01	Exposed drum along bank of Brandywine Creek; rubber substance	Not applicable	9/1/99	ND
TS-DC-02	Drum contents discovered in Test Pit #2 in the central section of site	7 feet bgs	9/1/99	68
TS-DC-03	Exposed drum along drainage ditch	Not applicable	9/1/99	ND
TS-DC-04	Drum contents discovered in a test pit along bank of Brandywine Creek	4 feet bgs	9/1/99	20
Surface Soil Samples (mg/kg)				
TS-SS-01	Along creek bank, near exposed drum in northwestern section of site	0-6 inches	8/31/99	22
TS-SS-02	Along creek bank in northwestern section of site	0-6 inches	8/31/99	1.4
TS-SS-03	Near center of site	0-6 inches	8/31/99	0.9
TS-SS-04	Drainage channel in southern section of site	0-6 inches	8/31/99	1.4
TS-SS-05	Near exposed drum in southern section of site	0-6 inches	8/31/99	0.89
TS-FD-01	Duplicate sample of TS-SS-05	0-6 inches	8/31/99	0.98
NS-1	North of 12th Street; west of Shellpot Creek (Norfolk Southern property)	0-6 inches	2/13/01	0.22 (J)
NS-2	North of 12th Street; west of Shellpot Creek (Norfolk Southern property)	0-6 inches	2/13/01	0.31 (J)
NS-3	North of 12th Street; west of Shellpot Creek (Norfolk Southern property)	0-6 inches	2/13/01	ND
NS-4	North of 12th Street; west of Shellpot Creek (Norfolk Southern property)	0-6 inches	2/13/01	0.099 (J)
NS-5	North of 12th Street; west of Shellpot Creek (Norfolk Southern property)	0-6 inches	2/13/01	0.088 (J)
NS-6	North of 12th Street; west of Shellpot Creek (Norfolk Southern property)	0-6 inches	2/13/01	ND
NS-7	South of 12th Street outside entrance gate to ARS Inc facility; between fenceline and Norfolk Southern rail line	0-6 inches	2/13/01	0.48 (J)
GH-8	North of 12th Street on Gander Hill Prison property; "right field" of the baseball field	0-6 inches	2/13/01	0.062 (J)
GH-9	North of 12th Street on Gander Hill Prison property; "right field" of the baseball field	0-6 inches	2/13/01	0.07 (J)
GH-10	North of 12th Street on Gander Hill Prison property; "right field" of the baseball field	0-6 inches	2/13/01	0.09 (J)

TABLE 2-3 (Continued)

ANALYTICAL SUMMARY – BIS(2-ETHYLHEXYL)PHTHALATE

Sample ID	Location	Depth	Date	Bis(2-ethylhexyl)phthalate
Surface Soil Samples (mg/kg)				
TS-SB-01	Test Pit #1 in the northern section of the site	10 feet bgs	8/31/99	1.1
TS-SB-02	Test Pit #2 in the central section of the site	6.5-7 feet bgs	9/1/99	3
TS-SS-01	Along creek bank, near exposed drum in northwestern section of site	0-6 inches	8/31/99	22
TS-SS-02	Along creek bank in northwestern section of site	0-6 inches	8/31/99	1.4
TS-SS-03	Near center of site	0-6 inches	8/31/99	0.9
TS-SS-04	Drainage channel in southern section of site	0-6 inches	8/31/99	1.4
TS-SS-05	Near exposed drum in southern section of site	0-6 inches	8/31/99	0.89
TS-FD-01	Duplicate sample of TS-SS-05	0-6 inches	8/31/99	0.98
NS-1	North of 12th Street; west of Shellpot Creek (Norfolk Southern property)	0-6 inches	2/13/01	0.22 (J)
NS-2	North of 12th Street; west of Shellpot Creek (Norfolk Southern property)	0-6 inches	2/13/01	0.31 (J)
NS-3	North of 12th Street; west of Shellpot Creek (Norfolk Southern property)	0-6 inches	2/13/01	ND
NS-4	North of 12th Street; west of Shellpot Creek (Norfolk Southern property)	0-6 inches	2/13/01	0.099 (J)
NS-5	North of 12th Street; west of Shellpot Creek (Norfolk Southern property)	0-6 inches	2/13/01	0.088 (J)
NS-6	North of 12th Street; west of Shellpot Creek (Norfolk Southern property)	0-6 inches	2/13/01	ND
NS-7	South of 12th Street outside entrance gate to ARS Inc facility; between fenceline and Norfolk Southern rail line	0-6 inches	2/13/01	0.48 (J)
GH-8	North of 12th Street on Gander Hill Prison property; "right field" of the baseball field	0-6 inches	2/13/01	0.062 (J)
GH-9	North of 12th Street on Gander Hill Prison property; "right field" of the baseball field	0-6 inches	2/13/01	0.07 (J)
GH-10	North of 12th Street on Gander Hill Prison property; "right field" of the baseball field	0-6 inches	2/13/01	0.09 (J)
TS-SB-01	Test Pit #1 in the northern section of the site	10 feet bgs	8/31/99	1.1
TS-SB-02	Test Pit #2 in the central section of the site	6.5-7 feet bgs	9/1/99	3
TS-SB-03	Test Pit #4 in the southern section of the site	7 feet bgs	9/1/99	1.1
TP-A	Test pit adjacent to southern end of sea wall	10 feet bgs	10/17/00	28
SW-1	Base of sea wall on Brandywine Creek side	1-2 feet bgs	10/18/00	3.1 (J)
Groundwater Sample (µg/L)				
TS-TP-03W	Test Pit #3 in the central section of the site	Not applicable	9/1/99	ND
Seep Sample (µg/L)				
SL-1	Seep area emanating from creek bank in southern section of site	Not applicable	10/3/00	1.2 (J)

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TABLE 2-3 (Continued)

ANALYTICAL SUMMARY – BIS(2-ETHYLHEXYL)PHTHALATE

Sample ID	Location	Depth	Date	Bis(2-ethylhexyl) phthalate
Sediment Samples (mg/kg)				
TS-SED-01	Mudflat along eastern bank of Brandywine Creek	0-6 inches	8/31/99	1
TS-SED-02	Mudflat along eastern bank of Brandywine Creek	0-6 inches	8/31/99	ND
SD-1	Upstream background sample from western bank of Brandywine Creek, adjacent to railroad bridge	0-6 inches	2/15/01	ND
SD-2	Upstream background sample from eastern bank of Brandywine Creek, approximately 100 yards upstream of railroad bridge	0-6 inches	2/15/01	0.088 (J)
SD-3	Downstream background sample from western bank of Brandywine Creek, directly across from weir/dam	0-6 inches	2/15/01	ND
SD-4	Downstream background sample from eastern bank of Brandywine Creek, approximately 100 yards downstream of dam/weir	0-6 inches	2/15/01	0.19 (J)
SD-5	Along sea wall, beneath a discharge pipe	0-6 inches	2/15/01	1.7
SD-6	Along sea wall, beneath a 12-inch discharge pipe	0-6 inches	2/15/01	0.11 (J)
SD-7	Mud flat along sea wall	0-6 inches	2/21/01	0.66 (J)
SD-8	Mud flat along sea wall; duplicate of SD-7	0-6 inches	2/21/01	ND
SD-9	Behind crumbling section of sea wall and beneath building foundation – appears to be creek sediment deposited during tidal events	0-6 inches	2/21/01	ND
Surface Water Samples (ug/L)				
SW-1	Upstream background sample from western bank of Brandywine Creek, adjacent to railroad bridge	Not applicable	2/15/01	ND
SW-2	Upstream background sample from eastern bank of Brandywine Creek, approximately 100 yards upstream of railroad bridge	Not applicable	2/15/01	ND
SW-3	Downstream background sample from western bank of Brandywine Creek, directly across from weir/dam	Not applicable	2/15/01	3.9 (J)
SW-4	Downstream background sample from eastern bank of Brandywine Creek, approximately 100 yards downstream of dam/weir	Not applicable	2/15/01	ND
SW-5	Along sea wall, beneath a discharge pipe	Not applicable	2/15/01	1.2 (J)
SW-6	Along sea wall, beneath a 12-inch discharge pipe	Not applicable	2/15/01	ND
SW-7	Along sea wall from a 4-inch discharge pipe that is apparently draining from building	Not applicable	2/15/01	1.6 (J)
SW-8	Eastern edge of Brandywine Creek, along sea wall	Not applicable	2/21/01	ND
SW-9	Eastern edge of Brandywine Creek, along sea wall; duplicate of SW-8	Not applicable	2/21/01	ND
SW-10	Eastern edge of Brandywine, Creek along sea wall	Not applicable	2/21/01	ND
Disposal Samples (mg/kg)				
SC-01	Composite sample collected from soil pile for disposal analysis	Not applicable	11/00	1.3

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Disposal Samples (mg/kg) (Continued)				
SC-02	Composite sample collected from soil pile for disposal analysis	Not applicable	11/00	1.7

Notes:

bgs Below ground surface
J Estimated result; actual value may not be accurate or precise
mg/kg Milligrams per kilogram
ND Not detected
ug/L Micrograms per liter

3.0 IDENTIFICATION OF REMOVAL ACTION OBJECTIVES

This section identifies the removal action scope, goals, and objectives and provides the statutory and regulatory framework within which the EE/CA is conducted.

3.1 STATUTORY FRAMEWORK

As defined by CERCLA and the NCP, removal actions include:

> the cleanup or removal of released hazardous substances from the environment, such actions as may necessarily be taken in the event of the threat of release of hazardous substances into the environment, such actions as may be necessary to monitor, assess, and evaluate the release or threat of release of hazardous substances, the disposal of removed material, or the taking of such other actions as may be necessary to prevent, minimize, or mitigate damage to the public health or welfare or to the environment, which may otherwise result from a release or threat of release.

Furthermore, removal actions have been categorized by EPA, based on the type of situation, urgency, threat of release or potential release, and the timeframe in which the action must be initiated. As stipulated by Section 300.415(b)(4) of the NCP, where a planning period of at least 6 months exists before on-site actions must be initiated and it has been determined that a removal action is necessary, the lead agency shall conduct an EE/CA to analyze RAAs for the site.

Section 300.415(b)(5) of the NCP stipulates that the cost and the duration of a removal action be limited to $2 million and 12 months, respectively. The statutory limits on removal actions apply only to fund-financed actions. Two types of exemptions to these statutory removal limits exist, in accordance with CERCLA Section 104(c)(1), 42 United States Code (USC) Section 9604(c)(1): the "emergency" waiver and the "consistency" waiver. The emergency waiver provides additional funding or extends the removal action time limit when continued response actions are immediately required to prevent, limit, or mitigate an immediate risk to public health or welfare or the environment. The consistency waiver provides additional funding or extends the removal action time limit to implement a removal action that is otherwise appropriate and consistent with the final response action to be taken. This action could possibly exceed both the $2-million and 12-month statutory limits. Exemptions to these statutory limits would have to be obtained for the 12th Street Landfill/Dump Site.

3.2 DETERMINATION OF REMOVAL SCOPE, GOALS, AND OBJECTIVES

The mitigation of potential impacts on human health and the environment is paramount at the 12th Street Landfill/Dump Site, and this document addresses these mitigative measures.

As defined by EPA in the initial planning stages of this investigation, the portion of the site to be fully addressed by this EE/CA was limited to the area that has historically been used as an unauthorized landfill. This area has been approximately identified during previous removal assessments, and a portion of this area was the focus of the April 2000 EPA time-critical removal action (Weston 2000). The On-Scene Coordinator (OSC) has determined that an evaluation of RAAs for Brandywine Creek sediments is not within the scope of this EE/CA because EPA's ability to address sediment posing ecological threats is severely limited; instead, the focus of removal actions for the 12th Street Landfill/Dump Site is to address the source of contamination. Surface water and groundwater will be addressed through engineering controls only "as needed" to implement the selected remedy for source mitigation.

The goal of the non time-critical removal action is to address the source of soil, groundwater, and surface water contamination. Site-specific removal action objectives (RAO) include:

- Minimize the potential for inhalation, ingestion, and direct contact exposure to contaminants.
- Minimize releases to Brandywine Creek that would result in contamination of sediments and surface waters at concentrations that may pose an unacceptable risk to human health or the environment.
- Minimize the release of contaminants from surface and subsurface soil into ambient air during removal activities.

Section 2.0 identifies the principal contaminants identified based on previous investigations at the 12th Street Landfill/Dump Site. Lead and arsenic are the principal contaminants to be addressed by a non time-critical removal action.

3.3 ESTIMATED QUANTITIES OF CONTAMINATED SOIL AND DEBRIS

Based on the results of characterization of the 12th Street Landfill/Dump Site presented in Section 2.0 and the RAOs identified in Section 3.2, preliminary area and volume estimates were generated for the purpose of identifying and evaluating RAAs. These estimates will be revised as additional characterization data is generated. The alternative evaluations in Section 4.0 are based on the following estimates of area, volume, and mass of contaminated soil and debris:

Area Currently Beneath Soil Cover

- The area of contamination is estimated to be approximately 700 by 225 feet, for a total area of 157,500 square feet (ft^2) or 3.6 acres.
- The average depth of contamination is estimated to be approximately 10 feet, yielding an in situ volume of 58,333 cubic yards (yd^3).
- Assuming an average in situ density of 3,000 pounds per yd^3 (lbs/yd^3), the estimated mass of contaminated material is 87,500 tons.
- Assuming the contaminated material is composed of 10 percent debris by weight or volume, contaminated soil is 52,500 yd^3 and 78,750 tons and debris is 5,833 yd^3 and 8,750 tons.

Newly Identified Area Across 12th Street to the North

- The area of contamination is estimated to be approximately 10,000 ft^2 or 0.23 acres.
- The average depth of contamination is estimated to be approximately 5 feet, yielding an in situ volume of 1,852 yd^3.
- Assuming an average in situ density of 3000 lbs/yd^3, the estimated mass of contaminated material is 2,778 tons.
- Assuming that the contaminated material is composed of 10 percent debris by weight or volume, contaminated soil is 1,667 yd^3 and 2,500 tons and debris is 185 yd^3 and 278 tons.

3.4 DETERMINATION OF REMOVAL SCHEDULE

The schedule for implementation of a non time-critical removal action at the 12th Street Landfill/Dump Site is flexible, depending on the nature of the alternative selected. Alternatives involving on-site treatment technologies will require a longer planning period and will probably have a longer implementation time than more traditional alternatives such as on-site containment or off-site disposal. An exemption to the 12-month statutory limit on removal actions would have to be obtained.

Weather is a consideration in determining the removal schedule. Winter snow, freezing temperatures, and seasonal rains can be expected to hamper most removal activities. Such factors will probably not affect the selection of alternatives significantly, but should be considered in the planning stage prior to implementation of an alternative.

3.5 POTENTIAL APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

The NCP states, "Removal Actions . . . shall to the extent practicable considering the exigencies of the situation, attain applicable or relevant and appropriate requirements under Federal environmental or state environmental or facility citing laws" (40 CFR §300.415(i)). Three factors determine whether the attainment of applicable or relevant and appropriate requirements (ARARs) is practicable in a given removal action (RA): (1) the exigencies of the situation, (2) the scope of the RA, and (3) the effect of ARAR attainment on statutory limits for RA duration and cost.

The following sections provide an overview of the ARARs process and a discussion of the potential effects of ARARs on the development of removal action objectives RAOs for the 12th Street Landfill/Dump Site.

3.5.1 Applicable or Relevant and Appropriate Requirements (ARARs) Overview

Identification of ARARs is site-specific and involves a two-part analysis: first, a determination of whether a given requirement is applicable; then, if it is not applicable, a determination of whether it is both relevant and appropriate. A requirement is deemed applicable if the specific terms of the law or regulation directly address the contaminant(s) of concern (COC), removal action, or area involved at the site. If the jurisdictional prerequisites of the law or regulation are not met, a legal requirement may nonetheless be both relevant and appropriate if circumstances at a site are sufficiently similar to circumstances in which the law otherwise applies and it is well-suited to the conditions of the site. The evaluation of a requirement's relevance and appropriateness is site-specific and must be based on best professional judgment. A requirement may be relevant, but not appropriate, for the specific site. In 40 CFR §300.400(g)(2), the NCP lists factors to consider in evaluating relevance and appropriateness. Only requirements that are determined to be both relevant and appropriate in light of these factors must be followed. Portions of a requirement may be relevant and appropriate, even if a requirement in its entirety is not.

A requirement must be substantive in order to constitute an ARAR for activities conducted on site. Procedural or administrative requirements, such as permits, reporting requirements, and agency approvals are not ARARs for on-site, CERCLA actions.

In addition to ARARs, the NCP provides that where ARARs do not exist, agency advisory criteria or guidance may be considered (termed "to-be-considered" [TBC] criteria) if useful "in helping to determine what is protective at a site or how to carry out certain actions or requirements" (55 Federal Register 8745). The NCP preamble states, however, that provisions in the TBC category "should not be required as cleanup standards because they are, by definition, generally neither promulgated nor enforceable, so they do not have the same status under CERCLA as do ARARs."

As the lead federal agency, EPA has the primary responsibility for the identification of federal ARARs at the 12th Street Landfill/Dump Site. The Resource Conservation and Recovery Act (RCRA), Clean Water Act (CWA), Safe Drinking Water Act, Clean Air Act (CAA), and their associated regulations are examples of federal laws from which ARARs may be derived.

As the lead state agency, DNREC has the responsibility for identifying state ARARS. In a letter dated February 22, 2000, the EPA requested that DNREC identify state of Delaware ARARs for a removal action at the 12th Street Landfill/Dump Site (EPA 2000a). DNREC identified these ARARs in a letter to EPA dated March 8, 2000 (DNREC 2000a). State standards that may constitute ARARs are those laws that are promulgated, substantive in nature, more stringent than federal requirements, consistently applied, and identified by the state in a timely manner.

ARARs and TBCs usually fall into one of the following three categories, based on the manner in which they are applied:

- **Chemical-specific ARARs** are usually health- or risk-based numerical values or methodologies that, when applied to site-specific conditions, result in the establishment of numerical values.
- **Location-specific ARARs** are restrictions placed on the concentrations of hazardous substances or the conduct of activities solely because they occur in special locations.
- **Action-specific ARARs** are usually technology- or activity-based requirements or limitations on the removal action taken at the site.

Determination of federal ARARs and TBCs for the 12th Street Landfill/Dump Site was made in accordance with CERCLA Section 121(d), the NCP (40 CFR 300), and EPA's two-part guidance document entitled, CERCLA Compliance with Other Laws Manual (EPA 1988, 1989a)

3.5.2 Potential Chemical-specific ARARs

This section summarizes potential chemical-specific ARARs identified for removal actions at the 12th Street Landfill/Dump Site.

3.5.2.1 Safe Drinking Water Act

The National Primary and Secondary Drinking Water Standards (40 CFR Parts 141, 143), better known as "maximum contaminant levels" (MCLs), are not applicable to removal activities at the site, because the shallow aquifer underlying the site is not a current or potential public water supply. In addition, groundwater is not within the scope of the proposed removal action.

3.5.2.2 Clean Water Act

Under the CWA, ambient water quality criteria (AWQC) are established to control pollution of navigable waterways. Because surface water is not within the scope of the EE/CA, AWQCs are not applicable; however, other provisions of the CWA may be relevant and appropriate to removal actions that involve discharge of contaminated water. AWQCs are important, because they could drive a need for further action; they are to be considered and used to guide protectiveness evaluations of remedial alternatives.

3.5.2.3 Resource Conservation and Recovery Act

<u>Groundwater Protection Standards</u>

Under 40 CFR Part 264, Subpart F, concentration limits are set for hazardous constituents in groundwater. These standards may be applicable to removal actions at the site. The limits specified for groundwater protection are the same as or less stringent than the MCLs or maximum contaminant level goals (MCLGs) identified for those substances.

The EPA has stated that the test for determining whether such standards may be relevant and appropriate to cleanups at Superfund sites is:

> RCRA Subtitle C requirements for the treatment, storage, or disposal of hazardous waste will be applicable if a combination of the following requirements are met: (a) the waste is listed or characteristic waste under RCRA; and (b) either (1) the waste was treated, stored, or disposed of after the effective date of the RCRA requirements (November 8, 1980); or (2) the activity at the CERCLA site constitutes treatment, storage or disposal as defined under RCRA (42 USC Section 6901 and following sections).

<u>Land Disposal Restrictions</u>

Land disposal restrictions (LDRs) may be ARARs for site soil if land disposal or placement of soil occurs, either with or without treatment, on- or off-site. LDRs typically set concentration levels or treatment standards that hazardous wastes must meet before they can be land disposed. These treatment standards represent best demonstrated available technology (BDAT) for these wastes.

3.5.2.4 Clean Air Act

Section 109 of the Clean Air Act (42 USC Section 7409) and implementing regulations found at 40 CFR Part 50 set national primary and secondary ambient air quality standards (AAQS). National primary AAQSs define levels of air quality that are necessary, with an adequate margin of safety, to protect public health. National secondary AAQSs define levels of air quality that are necessary to protect the public welfare from any known or anticipated adverse effects of a pollutant. AAQSs and other standards set out below may be relevant and appropriate for releases into the air resulting from removal actions.

The AAQS for particulate matter of less than or equal to 10 micrometers in diameter is 150 micrograms per cubic meter ($\mu g/m^3$) (24-hour average concentration) and 50 $\mu g/m^3$ (annual arithmetic mean) (40 CFR Section 50.6).

3.5.2.5 Occupational Safety and Health Administration

The Occupational Safety and Health Administration (OSHA) sets maximum permissible exposure levels (PEL) for worker exposure to airborne contaminants. OSHA PELs would be applicable to any action at the 12th Street Landfill/Dump Site. The OSHA PEL for lead, based on an 8-hour, time-weighted average (TWA) exposure, is 0.050 milligrams per cubic meter (mg/m^3). The OSHA TWA PEL for arsenic is 0.5 mg/m^3. The OSHA TWA PELs for total suspended particulates and respirable particulates are 15 and 5 mg/m^3, respectively.

3.5.2.6 Delaware Regulations Governing Hazardous Waste (Parts 261 and 264)

These state regulations identify and govern hazardous wastes and their treatment, storage, and disposal within the State of Delaware; specifically, the regulations identify arsenic and lead as hazardous wastes based on their toxicity. As such, these regulations would be applicable to removal actions at the 12th Street Landfill/Dump Site if alternatives involving land disposal and placement are selected.

3.5.2.7 Delaware Regulations Governing Hazardous Substance Cleanup

These regulations establish state standards for the identification, investigation, and cleanup of facilities with a release or imminent release of hazardous substances. These regulations are designed to protect public health, welfare, and the environment, while providing opportunities to encourage the remedy of facilities to yield economic revitalization and redevelopment within the State of Delaware. If additional removal actions are implemented at the 12th Street Landfill/Dump Site, these regulations may be applicable.

3.5.2.8 Delaware Regulations Governing Control of Air Pollution (Regulations 3 and 6)

These state regulations set AAQSs for specific contaminants and also regulate particulate emissions during construction and materials handling operations. These standards would be applicable to removal actions at the site if alternatives involving excavation and materials handling were selected.

3.5.2.9 State of Delaware Surface Water Quality Standards

These standards are designed to maintain water quality that is consistent with public health and recreation purposes, the propagation and protection of fish and aquatic life, and other beneficial uses of surface water in the State of Delaware. Surface water quality standards set by the State of Delaware would be applicable to removal actions at the site because of its proximity to Brandywine Creek, if alternatives involving excavation dewatering and surface water discharge were selected.

3.5.3 Potential Action-specific ARARs

Action-specific ARARs are technology- or activity-based requirements or limitations on actions taken with respect to hazardous wastes. These requirements are triggered by the particular remedial activities selected. RAs often include a discharge, such as treated or untreated groundwater or air emissions. The media being discharged and the destination of the discharge determine the requirements that are ARARs. Action-specific ARARs do not in themselves determine the remedial alternative; rather, they indicate how a selected alternative must be achieved. Therefore, because action-specific ARARs depend on the action selected, potential requirements will be discussed in general here and evaluated in greater detail in Section 4.0 during analysis of the long-term effectiveness of each removal alternative.

3.5.3.1 Resource Conservation and Recovery Act

The principal federal requirement of interest pertaining to the removal alternatives considered in this EE/CA is RCRA. As discussed above, RCRA requirements are applicable for classifying excavated material generated during the course of the RA and are managed on site. RCRA requirements may also be relevant and appropriate to excavated material that is similar or identical to RCRA hazardous waste.

However, for excavated material that is consolidated within the area of contamination (AOC) or treated in situ, EPA policy states that, the material is not generated and therefore is not a hazardous waste for RCRA purposes (55 Federal Register 8758 through 8760). Management of this material is not subject to LDRs or minimum technology requirements (such as liners and leachate collection systems for waste piles). However, ex situ treatment (such as incineration) or transfer of hazardous waste outside of the AOC will trigger RCRA requirements.

For hazardous waste sent off site to a disposal facility, the waste must meet the corresponding treatment standard promulgated under the LDRs. Similarly, the waste will be in compliance with all Department of Transportation requirements at 49 CFR Section 171 and 172 for the transportation of hazardous materials. However, because these activities would take place off site, they are not considered to be ARARs for the RA(s).

3.5.3.2 Clean Air Act

The federal CAA, 42 USC Section 7401 and following sections, establishes the National Ambient Air Quality Standards (NAAQS). NAAQS are not enforceable in and of themselves; they are translated into source-specific emissions limitations by the state. State rules that have been approved by EPA as part of the state implementation plan under the CAA are potential federal ARARs for air emissions (CAA Section 110).

3.5.3.3 Clean Water Act

Under the CWA, effluent limitations are enforced through National Pollution Discharge Elimination System permits, which specify numerical limits on discharges of pollutants to navigable waterways. Although permits would not be required for on-site CERCLA actions, effluent limitations would be relevant and appropriate to discharges of contaminated water to Brandywine Creek.

Under 40 CFR §§ 429.85 and 429.86, pretreatment standards are set for discharges from existing and new sources to publicly owned treatment works (POTW). These standards are applicable to discharges of "process wastewater" into a POTW and may be relevant and appropriate to discharges of contaminated treatment water from removal actions to a POTW.

3.5.3.4 Occupational Safety and Health Administration

OSHA sets forth a framework of regulations to ensure worker safety (29 CFR Part 1900). These regulations would be applicable to any action at the 12th Street Landfill/Dump Site. OSHA requirements cover a wide range of activities, including: worker training, personal protective equipment (PPE), construction, and exposure to airborne contaminants. Excavation requirements specified in 29 CFR Part 1926 Subpart P would be applicable to any alternative involving excavation.

3.5.3.5 Delaware Regulations Governing Hazardous Waste (Parts 261 and 264)

These state regulations identify and govern specific hazardous wastes and their treatment, storage, and disposal within the State of Delaware. As such, these regulations may be applicable to removal actions at the 12th Street Landfill/Dump Site if alternatives involving land disposal or placement of soil were selected.

3.5.3.6 Delaware Regulations Governing Hazardous Substance Cleanup

These state regulations establish state standards for the identification, investigation, and cleanup of facilities with a release or imminent release of hazardous substances. These regulations are designed to protect public health, welfare, and the environment, while providing opportunities to encourage the remedy of facilities to yield economic revitalization and redevelopment within the State of Delaware. If additional removal actions are implemented at the 12th Street Landfill/Dump Site, these regulations may be applicable.

3.5.3.7 Delaware Sediment and Storm Water Regulations

These state regulations govern the use of erosion and sedimentation controls during construction and post construction activities; in addition, these standards dictate storm water management practices to be implemented during these activities. These regulations would be applicable to removal actions at the 12th Street Landfill/Dump Site.

3.5.3.8 Delaware Regulations Governing Control of Air Pollution (Regulations 3 and 6)

These state regulations set AAQSs for specific contaminants and regulate particulate emissions during construction and materials handling operations. These standards may be applicable to removal actions at the site if alternatives involving excavation and materials handling are selected.

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3.5.3.9 State of Delaware Surface Water Quality Standards

These standards are designed to maintain water quality that is consistent with public health and recreation purposes, the propagation and protection of fish and aquatic life, and other beneficial uses of surface water in the State of Delaware. Surface water quality standards set by the State of Delaware may be applicable to removal actions at the site because of its proximity to Brandywine Creek and the potential need for excavation dewatering and surface water discharge operations.

3.5.4 Potential Location-specific ARARs

The following potential location-specific ARARs have been identified for the 12th Street Landfill/Dump Site:

- Floodplain Management Order, Executive Order No. 11988. 40 CFR Part 6, Appendix A, dictates that federally funded or authorized actions within the 100-year flood plain avoid, to the maximum extent possible, adverse impacts with development of a flood plain. Compliance with this requirement is detailed in EPA's Policy of Floodplains and Wetlands Assessments for CERCLA Actions (August 6, 1985). Procedures require the determination of whether the proposed remedy will be in, or will affect, wetlands. If so, a wetlands assessment must be prepared. Specific measures to minimize adverse impacts should be identified following consultation with the appropriate agencies prior to implementation of a selected removal action.

- Protection of Wetlands Order, Executive Order No. 11990. The requirements of this Executive Order, found at 40 CFR Part 6, Appendix A, mandate that federal agencies and potentially responsible parties avoid, to the extent possible, the adverse impacts associated with the destruction or loss of wetlands and to avoid support of new construction in wetlands if a practicable alternative exists. In addition, this Executive Order requires agencies to consider factors relevant to a proposal's effect on the survival and quality of the wetlands and to take actions to preserve and enhance the natural and beneficial values of wetlands in carrying out the agencies' responsibilities. Some wetlands may be present to the south of the 12th Street Landfill/Dump Site.

- Delaware Regulations Governing the Use of Subaqueous Lands. These regulations govern the use and management of areas designated as wetlands. Since wetlands are present in the vicinity of the site, these regulations may be applicable to removal actions.

- Regulations Governing Delaware's Coastal Zone. These regulations were developed to promote improvement of the environment within the Coastal Zone. Due to the site's location within the designated Coastal Zone, these regulations would be applicable to removal actions at the 12th Street Landfill/Dump Site.

Although the Endangered Species Act, the National Historic Preservation Act, and the Archaeological and Historic Preservation Act were identified as potential ARARs, no species or objects encompassed within these acts were identified during the time-critical removal action; therefore, these acts are not considered to be ARARs for remedial actions at the site.

Also, EPA has determined that the requirements of the National Environmental Policy Act (NEPA) are no more stringent than the requirements for environmental review under CERCLA and the NCP. Therefore, NEPA is not considered to be an ARAR for CERCLA actions.

3.5.5 Federal Standards To Be Considered

Many of the procedures and standards to be used in a CERCLA action are set forth in guidance documents issued by EPA. A list of the types of guidance that are TBC is included in the preamble to the Final NCP, 55 Federal Register 8765 (March 8, 1990). That guidance, along with current updates of, and additions to, that guidance, is to be considered in selecting and implementing the remedy at the site.

The following chemical-specific TBCs have been identified:

- EPA Region 3 RBC Table (EPA 2000d). EPA Region 3 prepares this table for screening purposes. RBC values are not intended to serve as action levels, because each site warrants a site-specific evaluation of risk. However, in the absence of a site-specific risk analysis, these values provide a frame of reference for the consideration of removal action levels. No RBC has been established for lead. The industrial RBC for arsenic is 3.8 mg/kg.

- EPA's Interim Guidance on Establishing Soil Lead Cleanup Levels at Superfund Sites (EPA 1989b). This guidance recommended a soil lead cleanup level of 500 to 1,000 mg/kg for protection of human health at residential CERCLA sites; however, lead screening levels are not provided for industrial use sites.

- EPA's Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities (EPA 1994). This guidance document recommends screening levels for lead in soil for residential land use at 400 mg/kg; however, lead screening levels are not provided for industrial use sites. Screening levels are not TBC cleanup levels, but rather are defined as a level of contamination above which a site-specific study of risks may be warranted. Levels of contamination above the screening level would not automatically require a removal action, or cause a site to be classified as "contaminated."

- AWQCs (EPA 1999b). AWQC values are used to provide guidance in evaluating the protectiveness of RAAs. As such, they may drive the need for potential future removal response actions at the site.

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4.0 IDENTIFICATION AND ANALYSIS OF REMOVAL ACTION ALTERNATIVES

Section 4 provides the rationale for identification and initial screening of potentially applicable technologies and a detailed evaluation of the selected alternatives. Section 4.0 is organized into two subsections to present the following information:

- Section 4.1 describes the approach and rationale used in the initial identification and screening of technologies and the development of alternatives to be evaluated.
- Section 4.2 provides a detailed evaluation and analysis of the alternatives developed in Section 4.2.

Based on the objectives presented in the previous section, eight alternatives were developed for the removal action at the 12th Street Landfill/Dump Site. These alternatives are described in the following sections and were evaluated based on effectiveness, implementability, and cost. This evaluation follows EPA's guidance on conducting non time-critical removal actions.

4.1 IDENTIFICATION OF APPROPRIATE TECHNOLOGIES

This section summarizes the identification and screening of removal technologies that are potentially applicable at the site. General Response Actions (GRAs), describing measures that satisfy RAOs, are developed in Section 4.1.1, including estimates of the areas and volumes to which the response actions may be applied. Finally, in Section 4.1.2, removal technologies applicable to each action are identified and evaluated with respect to their effectiveness, implementability, and to a limited extent, cost. The applicable technologies are then assembled into medium-specific removal alternatives in Section 4.2.

4.1.1 General Response Actions

The purpose of this section is to develop GRAs for soil. GRAs are conceptual alternatives that could meet applicable RAOs for the site. GRAs are normally medium-specific and may include, but are not limited to, treatment, containment, excavation, extraction, disposal, institutional controls, or a combination of some or all of these measures. "No Further Action" (NFA) is also included for comparison.

GRAs for soil are presented below:

- **NFA.** A soil cover and runoff control measures were installed over the primary area of contamination during the April 2000 EPA time-critical removal action. The NFA GRA serves as a baseline for comparison with other potential soil GRAs. Human health and environmental risks posed by site contaminants would remain the same. RAOs for surface water and sediment may not be achieved if contaminants leach to Brandywine Creek at concentrations exceeding RBCs or water quality criteria; however, installation of a soil cover and runoff control measures may have been effective at reducing leaching by reducing infiltration of precipitation through the zone of contamination. Direct contact, ingestion, and inhalation hazards associated with the newly identified area of contamination to the north would not be addressed. If NFA is implemented at the site, substances would remain in the soil, serving as a potential source of contamination to surface water and groundwater. However, the flushing of inorganic constituents from the soil would be a very slow process, and low concentrations of leachate would be expected over a long period of time.

- **Institutional Controls (ICs).** ICs are administrative methods for preventing or limiting access to affected environmental media. For soil, ICs may include governmental controls such as zoning restrictions, proprietary controls such as a covenant to the property, or information controls such as a deed notice or restriction. Similar to NFA, ICs alone would not meet RAOs.

- **Containment.** Soil can be contained to prevent direct contact by receptors or to restrict the migration of contaminants into adjacent soil, groundwater, air, and nearby watercourses. Containment is often accomplished through the use of a physical barrier but, in itself, would not reduce the toxicity or volume of the contaminants. Containment measures were implemented during the April 2000 EPA time-critical removal action. The placement of soil cover over the landfill, temporary sheet piling along Brandywine Creek, and ACBs and riprap on the creek bank prevent direct contact with contaminated soil and minimize erosion; however, leaching of contaminants to groundwater and surface water may not have been completely eliminated. Improvements to existing containment features or addition of containment features in the area of contamination not currently covered by EPA's time-critical removal action could further reduce potential exposure to contaminants by minimizing infiltration of precipitation through the waste and tidal flushing of surface water.

- **Excavation.** Excavation of contaminated soil would be performed using standard construction equipment to remove a specified volume of soil and debris. The soil would either be stockpiled or placed directly into a dump truck. This GRA would be implemented in conjunction with consolidation, off-site disposal, or treatment.

- **Consolidation.** This GRA entails combining materials from one location with those of other locations and is accomplished through the use of loaders, dump trucks, and compaction equipment. Soil excavated in one area of the site would be consolidated with similar wastes for containment, treatment, or disposal in another area of the site. This GRA alone will not meet RAOs, but when combined with excavation, containment, treatment, or disposal, may be effective in reducing the risk to human health and the environment.

- **Disposal.** Once material has been excavated, it may be properly disposed of at an off-site facility permitted to accept the waste material. When combined with excavation or treatment, disposal could meet RAOs. Disposal options will be considered for contaminated soil.

- **Treatment**. Treatment technologies are processes that reduce the toxicity, mobility, or volume of contaminants. Typical technology types employed for treatment include physical, chemical, thermal, or biological processes. Depending on the characteristics of the soil to be treated, a combination of processes may be necessary to properly treat the wastes. Treatment processes can be employed either on site, off site, or in situ and could potentially meet the RAOs. Based on the nature of contamination (primarily inorganic contaminants) at the 12th Street Landfill/Dump Site, thermal and biological treatment technologies are not appropriate.

4.1.2 Identification and Screening of Removal Technologies

GRAs for contaminated soil, as identified in Section 4.1.1, include NFA, ICs, excavation, containment, consolidation, disposal, and treatment. The purpose of this section is to identify and screen potential remedial technologies and process options that may be applicable to identified GRAs at the site.

Each of the technologies in this section will be subject to a preliminary screening process and evaluated based on the effectiveness of the technology, implementability of the technology, and to a much lesser extent, cost. The following sections are organized by GRA and present technology descriptions, followed by a summary of the technology screening evaluation. Process options associated with a specific technology are identified, when applicable. The effectiveness evaluation focuses on the ability of technologies to attain RAOs, the reliability of the technology, and potential impacts during implementation. Permitting requirements, public and government agency acceptance, and the availability of equipment and services are evaluated as part of the implementability screening. Finally, process options are evaluated based on cost relative to other process options associated with each technology. The results of the screening process are summarized in Table 4-1.

4.1.2.1 No Further Action

This option is included to serve as a reference in comparing the removal technologies. No removal action technology would be used to address soil contamination at the site.

Effectiveness. This option provides no additional effectiveness in reducing the volume of contaminated soil or in protecting human health and the environment. The human health risk would be the same as currently present at the site. RAOs would not be met, because risk of exposure to the newly identified area of contamination to the north of 12th Street would not be addressed.

Implementability. This action is technically and administratively implementable.

Cost. No costs are associated with this action.

4.1.2.2 Institutional Controls

ICs are actions taken to reduce the potential for exposure to contaminated soil. ICs may include deed restrictions or notices on future land use. For example, the property could be restricted to future industrial use. Other restrictions could be imposed such as limitations on future excavation or development activities. Deed notices would inform future property owners that the site is or was the scene of a CERCLA removal action.

Effectiveness. ICs do not reduce contamination and therefore have only limited effectiveness. However, combined with other technologies, ICs may be effective in reducing the human health and environmental risks. If only ICs are implemented, sources will remain in the soil and may migrate to other media such as air, groundwater, and nearby surface water. As a result, RAOs to eliminate such migration would not be met, specifically, for the newly identified area of contamination to the north of 12th Street.

Implementability. Deed notices can be implemented. Legal requirements and authority must be established; notices on the property may (1) generate opposition from the owner or community, (2) have an economic impact, and (3) be difficult to enforce. Land use restrictions under a future residential scenario are administratively difficult to implement.

Cost. The cost of implementing ICs is relatively low.

TABLE 4-1

SUMMARY OF TECHNOLOGY SCREENING
12TH STREET LANDFILL/DUMP SITE

General Response Action	Removal Technology	Process Option	Effectiveness	Implementability	Cost	Screening Results
No Further Action	None	No action	Existing soil cap restricts direct contact with surface soil, but does not prevent leaching to Brandywine Creek	No action necessary	None	Retained. Provides baseline for comparison to other alternatives.
Institutional Controls	Institutional controls	Deed restrictions	Limited. Can reduce direct contact with soil but requires enforcement. Does not address leaching to Brandywine Creek.	Implementable, but difficult to enforce	Low	Retained. Provides a limited action alternative.
		Deed notices	Limited. Alerts potential buyers to contamination, but does not address leaching to Brandywine Creek.	Implementable	Low	Retained. Provides a limited action alternative.
Disposal	Off-site landfill	RCRA Subtitle C landfill	Effectively removes contaminants from the site. Short-term risks are associated with excavation and transportation of contaminated soil.	Implementable. Macroencapsulation or microencapsulation would probably be required at disposal facility to meet LDRs.	High because of RCRA Subtitle C disposal requirements	Retained. Provides a highly effective alternative.
	Off-site landfill	RCRA Subtitle D landfill	Effectively removes contaminants from the site. Short-term risks are associated with excavation and transportation of contaminated soil.	Implementable. On-site treatment would probably be required to remove the hazard characteristics prior to shipment.	High because of treatment requirements	Retained. May be applicable for debris or treated soil.
Containment	Engineered cover	Low-permeability cap	Limited. Reduces leaching by reducing infiltration from precipitation, however, does not prevent tidal flushing and groundwater migration. Increased effectiveness if used in conjunction with a vertical barrier.	Implementable. Requires standard construction equipment and readily available materials.	Moderate	Retained. Provides a cost-effective element of on-site containment alternatives.
	Engineered vault	RCRA-quality vault	Effectively restricts direct contact with contaminated soil and greatly reduces or eliminates leaching. Subject to long-term erosion from Brandywine Creek.	Implementable. Requires standard construction equipment and readily available materials. Siting may not be appropriate because of flooding. Requires excavation and temporary storage of all contaminated material during construction.	High	Rejected. Temporary storage of contaminated material is impractical and presents short-term risks.

TABLE 4-1 (Continued)

SUMMARY OF TECHNOLOGY SCREENING
12TH STREET LANDFILL/DUMP SITE

General Response Action	Removal Technology	Process Option	Effectiveness	Implementability	Cost	Screening Results
Containment (Continued)	Vertical barrier	Sheet piling	Limited. Reduces leaching from tidal flushing and groundwater migration. Seepage between sheet piling and shallow bedrock would be difficult to prevent.	Implementable. Temporary sheet piling was installed along Brandywine Creek for the 2000 removal action.	Moderate	Rejected. Long-term effectiveness is limited by corrosion and leakage.
		Slurry wall	Effectively reduces leaching from tidal flushing and groundwater migration. Can be keyed into bedrock to minimize seepage.	Implementable. Requires standard construction equipment and techniques and readiliy available materials.	Moderate	Retained. Provides a cost-effective element of on-site containment alternatives.
		Slurry injection	Effectiveness is dependent on site-specific hydrogeology.	Implementable.	Moderate	Rejected. Slurry trench is more reliable at comparable cost.
Excavation	Excavation	Not applicable	Not effective by itself, but a required element of any ex situ treatment or off-site disposal alternative. Increased short-term risks associated with excavation.	Implementable with standard equipment. Excavation below water table would require dewatering measures.	Moderate	Retained. An integral element of ex situ treatment or off-site disposal alternatives.
Treatment	Physical/ chemical treatment	In situ solidification/ stabilization	Generally effective and reliable for reducing leachability of inorganics. Reduces mobility but increases volume of contaminants. Treatability study would be recommended to evaluate site-specific capabilities.	Implementable, but large quantities of hoses and debris would have to be segregated from soil. Dewatering would be required for contamination below water table.	Moderate to high	Rejected. Logistically difficult to implement properly.
		In situ injection stabilization	Effectively reduces permeabilty and leachability in coarse-grained formations. Limited effectiveness in fine-grained soils. Pilot study would be recommended to evaluate site-specific capabilities.	Implementable with standard equipment and techniques; however, technical feasibility for 12th Street Landfill requires further evaluation.	High	Retained. May be effective depending on site-specific geology.

TABLE 4-1 (Continued)

SUMMARY OF TECHNOLOGY SCREENING
12TH STREET LANDFILL/DUMP SITE

General Response Action	Removal Technology	Process Option	Effectiveness	Implementability	Cost	Screening Results
Treatment (Continued)	Physical/ chemical treatment	Ex situ solidification/ stabilization	Generally effective and reliable for inorganics. Reduces mobility but increases volume of contaminants. Treatability study would be recommended to evaluate effectiveness.	Implementable - will require segregation and disposal of stabilized soil and debris.	High	**Retained.** May prove capable of reducing off-site landfill costs.
	Size separation	Soil washing	Generally effective at concentrating inorganic contaminants in the fine fraction of soil. A treatability study would be recommended to evaluate site-specific capabilities.	Implementable - will require segregation and disposal of contaminated soil and debris - only reduces the volume of contaminated soil.	High	Retained. May prove capable of reducing off-site disposal costs.
		Screening	Effective for segregating debris. A necessary first stage of any treatment train.	Implementable. Equipment and services are readily available.	Low	Retained. A required element of ex situ treatment alternatives.

Note:

LDR Land disposal restriction
RCRA Resource Conservation and Recovery Act

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4.1.2.3 Containment

Capping, covering, or vertical barrier containment technologies are potentially applicable to many contaminated sites. In general, installing a final cover: (1) eliminates human or animal contact with contamination; (2) minimizes contact between wastes and surface runoff, thereby controlling off-site transport of contaminated sediment; (3) minimizes contact of wastes with infiltration, thereby reducing the potential for leaching of contaminants into groundwater; and (4) eliminates the potential for contaminants to become airborne through wind erosion. Final cover materials may consist of synthetic membranes, soil, asphalt, concrete, or chemical sealants. Prior to installation, significant recontouring of the site may be required to increase effectiveness of the cover and to promote proper drainage. Vertical barriers may consist of slurry walls, sheet piling, clay dikes, or high-pressure injection-grouted, low-permeability walls.

Final cover is generally placed as part of a controlled landfill closure, but is similar for containment of an uncontrolled waste site. Containment is sometimes performed when excavation and removal of wastes is precluded by potential hazards or prohibitive costs (for example, excessive volume). Containment may also be performed as a measure to reduce potential transport of contaminants to other media.

Containment measures were implemented at the 12th Street Landfill/Dump Site during the April 2000 time-critical removal action, including: placement of a 2-foot soil cover over the former landfill/dump area to eliminate direct contact; installation of temporary sheet piling to stabilize the bank of the creek; and placement of ACBs and riprap along the creek bank to minimize erosion. These measures do not completely eliminate migration of contaminants through leaching; however, they do significantly reduce the potential for migration, as described above.

Effectiveness. A properly installed containment system would prevent receptor exposure to contaminated soil through dermal contact, ingestion, or inhalation, because the contaminated soil would be physically isolated. However, contaminants would remain on site untreated. If used in conjunction with treatment, containment with a low-permeability cover would reduce the potential for leachate generation, direct contact, and migration of contaminants through surface water runoff.

One means to prevent potential damage to a cover or potential future exposures would be to impose deed restrictions to limit excavations. These restrictions are difficult to enforce and therefore may not be effective in preventing exposure of potential future residents to contaminated material.

Implementability. Technologies for containment systems are reliable and well demonstrated. The materials, equipment, and necessary labor are readily available for all cover and vertical barrier types.

A final cover would require long-term monitoring and maintenance to ensure effectiveness. Should the site be developed in the future, installation of utilities or other development activity would likely cause significant damage to the cover. Future use activities at the site may reduce the cover life or increase maintenance costs.

Installation of an impermeable cover would decrease the amount of water infiltrating into the soil and therefore would increase runoff. Depending on the type of cover, the increase in runoff could be significant. Runoff control measures would need to be designed to control this increased storm water runoff and prevent erosion of the cover.

Cost. The cost of installing a cover over the site would be low to high, depending on the type of system installed.

4.1.2.4 Excavation

Excavation involves the physical removal of soil using conventional heavy construction equipment (such as backhoes and bulldozers).

Effectiveness. Excavation alone would not meet RAOs, but would be required for any ex situ treatment or off-site disposal alternatives.

Implementability. Excavation technology is extremely reliable and well demonstrated. If excavation beneath the water table is necessary to remove all visible contamination, dewatering may be required. Excavations would have to comply with OSHA regulations regarding shoring and sloping requirements. Caution will need to be exercised when excavating around structures and utilities. Dust and erosion control measures should be implemented.

Cost. The costs to implement this technology are moderate.

4.1.2.5 Consolidation

Consolidation would involve excavating materials from one on-site location and combining them with those of another on-site location. Consolidation would be performed using loaders, dump trucks, and compaction equipment to haul the material from one area to another and then backfill, grade, and compact the material.

Effectiveness. Consolidation alone would not meet RAOs, but could provide increased effectiveness or reduce overall costs of containment technologies.

Implementability. Consolidation is reliable, well demonstrated, and easy to implement.

Cost. The costs to implement this technology are low to moderate.

4.1.2.6 Off-site Disposal

Off-site disposal would involve excavating contaminated soils and hauling them to a RCRA-approved landfill. Excavation and hauling would be accomplished using conventional heavy construction equipment (such as backhoes, bulldozers, and dump trucks).

Effectiveness. Landfilling is an effective and reliable method for disposal of the types of contamination present at the site. RAOs would be met; however, the CERCLA preference for treatment technologies that reduce toxicity, mobility, or volume of contaminants would not be satisfied.

Implementability. The physical aspects of off-site disposal would be easily implemented, but transportation to an off-site landfill would increase traffic in residential areas, if any, and therefore increase the potential for spills, accidents, and noise nuisances. Off-site disposal at the capacity required is available. Landfill facilities must hold the proper state or federal permits and be in compliance with applicable regulations.

Cost. The cost to implement disposal at an off-site facility would be high, assuming that the contaminated soil would be identified as a characteristic hazardous waste, based on toxicity characteristic leachate procedure (TCLP) analysis, thereby triggering LDRs and disposal at a RCRA Subtitle C Landfill.

4.1.2.7 Treatment

Soil treatment would involve removing, immobilizing, or destroying contaminants, thereby reducing their volume, toxicity, or mobility. Several types of treatment technologies are available, including physical/chemical, thermal, and biological technologies. Depending on the specific technology, treatment could be performed either in situ or ex situ. Generally, each treatment type is specific to either organic or inorganic contaminants. Thermal and biological treatment technologies are primarily applicable to organic contaminants and will not be considered for the inorganic contaminants present at the 12th Street Landfill/Dump Site.

Physical treatment processes can be used to separate the waste stream by either applying physical force or changing the physical form of the waste, whereas chemical treatment processes alter the chemical structure of the constituents to produce a waste residue that is less hazardous than the original waste. Further, altered constituents may be easier to remove from the waste stream. Physical and chemical processes can also be used to immobilize contaminants within the waste material. Physical and chemical treatment processes are used to treat inorganic, as well as organic hazardous wastes, particularly those that are either non biodegradable or resistant to biodegradation. Possible physical/chemical treatment technologies that were initially identified for the site include solidification/stabilization (S/S), soil washing, and chemical reduction. These technologies are discussed below.

- **S/S** - S/S treatment systems, sometimes referred to as fixation or immobilization technologies, are employed to improve the handling and physical characteristics of the waste, reduce the surface area across which transfer or loss of contaminants can occur, or reduce the solubility of hazardous constituents in the wastes. Solidification involves the addition of a binder, such as cement or lime, in order to solidify free liquids. No reduction in the leachability of hazardous constituents occurs. Stabilization involves mixing waste with specific types, and usually larger quantities, of binder to immobilize the hazardous constituents in the solid matrix. A design S/S reagent mix is determined prior to treatment using a treatability study on the soil or waste present at the site. Most of the techniques involve a thorough mixing of the solidifying agent and the waste. This is accomplished in situ with large-diameter augers that mix the solidifying/stabilizing agent with the soil or wastes. This process can also be accomplished ex situ, combined with excavation and consolidation. Alternatively, stabilizing slurries can be injected into a formation under pressure to displace air and water in void spaces within the soil matrix, thereby reducing hydraulic conductivity and leaching potential. Solidification, which can be achieved with relatively small amounts of binder, converts the waste into a soft, granular solid. Stabilization can produce a hard, monolithic solid mass or create more subtle changes in the physical and chemical properties of soil, such as reduced permeability and leachability or increased strength. Volume increases from 10 to 50 percent occur as a result of S/S. Removal actions involving combinations of S/S techniques are often used.

- **Soil Washing and Solvent Extraction** - The soil washing and solvent extraction processes extract contaminants from sludge or soil matrices using a liquid washing solution. During the soil washing process, the vast majority of soil contaminants are adsorbed to the finer fractions of the soil. Finer soils are separated from the coarser soils, concentrating the contaminants and resulting in waste volume reduction. With solvent extraction, contaminants are dissolved in the liquid solvent (EPA 1990b).

The washing solution may be composed of water, organic solvents, water/chelating agents, water/surfactants, acids, or bases, depending on the contaminant to be removed. After soil treatment, the washing solution is treated for removal of fines and contaminants through a conventional wastewater treatment system. The treated solution is then recycled to the beginning of the process. The washed soil may then be used as clean fill material. The treatment waste stream (that is, concentrated contaminants) may require additional treatment prior to disposal (EPA 1990b). Soil washing is generally used to treat soil with inorganic contaminants; however, some vendors claim removal of organics as well.

- **Chemical Reduction** - The chemical reduction process is employed to convert the hazardous components of the waste stream into less hazardous forms. Reduction processes are based on reactions between the waste components and added reactants in which the oxidation state of one reactant is raised, while that of another is lowered. An example of chemical reduction is the reduction of hexavalent chromium to trivalent chromium, which is less toxic and more susceptible to chemical precipitation. Reduction has also been used to treat mercury-, silver-, and lead-contaminated wastes. Common reducing agents include alkali metals (such as sodium, potassium), sulfur dioxide, sulfite salts, ferrous sulfate, iron, aluminum, zinc, and sodium borohydrides. The chemical reduction treatment process consists of initial pH adjustment, addition of reduction reagents, mixing, and treatment to remove or precipitate the reduced or oxidized products. Chemical reduction has limited application to soil because of difficulties in achieving intimate contact between the reagent and the hazardous constituent. Soil must be slurried prior to treatment to achieve a suspended solids content of 3 percent or less.

The physical/chemical treatment technologies potentially applicable to the 12th Street Landfill/Dump Site are S/S and soil washing/solvent extraction. These technologies are the BDATs for inorganic contaminated soil and debris (EPA 1990a, 1990b, 1990c). Chemical reduction is not considered to be cost effective or technically practicable for the soil matrix and is not retained for further consideration.

Effectiveness. S/S can be effective for immobilization of inorganics in soil (EPA 1989b). Long-term effectiveness in reducing contaminant leachability has not been determined for the 12th Street Landfill/Dump Site. However, because the primary contaminants (arsenic and lead) are inorganics, S/S may be effective. This technology is normally used to treat soils so that they can be classified as non hazardous, as defined by RCRA (40 CFR Part 261), based on leachate characteristics.

Soil washing/solvent extraction is a well-proven technology for inorganic contaminants; however, site-specific conditions, such as contaminant separation coefficients, complex mixtures of waste (such as metals with organics), high humic content in soil, soil solvent reactions, excessively fine soils (such as silts and clays), and unfavorable washing solution characteristics, can affect performance (EPA 1990b). Therefore, a treatability study would be recommended to evaluate the effectiveness of this technology.

Implementability. All of the physical/chemical treatment technologies discussed can be implemented with readily available equipment and services. No permitting problems would be expected with these technologies.

Cost. The costs associated with physical/chemical treatment technologies would be moderate to high, depending on the technology. Implementation of in situ S/S would be hampered by the presence of large pieces of buried debris. Ex situ S/S costs would be moderate to high, depending on the need to dispose of the stabilized mass off-site. Soil washing/solvent extraction would incur moderate to high costs, depending on site-specific conditions. For example, if on-site soil contains excessive fines, the amount of material for final disposal and associated disposal costs would increase.

4.2 EVALUATION AND ANALYSIS OF REMOVAL ACTION ALTERNATIVES

Based on the screening of technologies presented in Section 4.1, the following RAAs have been identified for a detailed evaluation and analysis of effectiveness, implementability, and cost:

- Alternative 1 – NFA
- Alternative 2 – ICs
- Alternative 3 – Soil Cover over Contaminated Areas
- Alternative 4 – Excavation and Off-site Subtitle C Landfill
- Alternative 5 – Consolidation and Containment
- Alternative 6 – Consolidation and Injection Stabilization
- Alternative 7 – Excavation, Debris Screening, On-site S/S, and Off-site Subtitle D Landfill of Treated Soil and Debris
- Alternative 8 – Excavation, Debris Screening, Soil Washing, Backfill of Clean Soil, Off-site Encapsulation and Subtitle C Landfill of Contaminated Soil, and Off-site Subtitle D Landfill of Debris

4.2.1 Alternative 1 – No Further Action

The following sections describe and discuss the effectiveness, implementability, and costs associated with Alternative 1.

4.2.1.1 Description

Under this alternative, no further removal actions would be conducted at the 12th Street Landfill/Dump Site. High concentrations of contaminants would remain in subsurface soil beneath a 2-foot soil cover and exposed at the surface in the area north of 12th Street. The NFA alternative is retained for detailed analysis to serve as a baseline comparison for other alternatives.

4.2.1.2 Effectiveness

This alternative would not provide any increased protection of human health or the environment. The potential for migration of contaminants to groundwater and surface water through leaching would remain; however, the April 2000 time-critical removal action may have effectively reduced leaching of contaminants to acceptable levels. The potential for exposure of contaminants through future development activities or erosion of the soil cover would remain.

The NFA alternative would not trigger ARARs; therefore, compliance with ARARs would not be an issue.

This alternative would not provide any additional measure of long-term effectiveness or permanence, nor would it present any new risks or have any adverse impacts during implementation, because no further removal action would be conducted. No reduction of toxicity, mobility, or volume through treatment would be achieved.

4.2.1.3 Implementability

This alternative is readily implementable from a technical and administrative standpoint, because no activities would occur.

4.2.1.4 Cost

No costs are associated with Alternative 1.

4.2.2 Alternative 2 – Institutional Controls

The following sections describe and discuss the effectiveness, implementability, and costs associated with Alternative 2.

4.2.2.1 Description

Under this alternative, only ICs would be implemented. ICs that are potentially feasible for the 12th Street Landfill/Dump Site include monitoring, access restrictions, and deed notices. Included in this alternative is the filing of deed notices and deed restrictions on the property. It is further assumed that the State of Delaware will perform long-term monitoring and maintenance on the property to ensure that the site is not disturbed and that the current cover is not compromised. This alternative is retained for detailed analysis to provide EPA with an option for conducting limited action at the site. RAOs would not be met under this alternative, specifically for the newly identified contamination to the north of 12th Street. This alternative could be implemented in conjunction with any of the other alternatives evaluated.

4.2.2.2 Effectiveness

This alternative does not address the potential threat posed by subsurface migration of contaminants into Brandywine Creek. ICs would provide a limited degree of short- and long-term effectiveness by warning prospective property purchasers of the contaminants present, limiting possible development of the site, and restricting the unearthing of contaminants present at the site.

4.2.2.3 Implementability

These measures are technically feasible, but administratively difficult to maintain in both the short and long term. In addition, they are not readily enforceable.

4.2.2.4 Cost

The costs associated with Alternative 2 would include only the services of an attorney or consultant in order to support the development of deed notices and restrictions. It is assumed that the State of Delaware will incur costs associated with long-term monitoring and maintenance; therefore, those costs are not included in this alternative. The total cost to EPA for implementing this alternative is assumed to be less than $1,000.

4.2.3 Alternative 3 – Soil Cover over Contaminated Areas

The following sections describe and discuss the effectiveness, implementability, and costs associated with Alternative 3.

4.2.3.1 Description

A soil cover was installed over the primary area of contamination (south of 12th Street) during the April 2000 EPA time-critical removal action. Under this alternative, a similar soil cover would be placed over the newly identified area of contamination to the north of 12th Street. The cover would be contoured and revegetated to promote proper drainage away from the contaminated material. Vegetation would be established to minimize erosion.

4.2.3.2 Effectiveness

This alternative does not eliminate the potential threat posed by subsurface migration of contaminants into Brandywine Creek; however, it would reduce this threat and may be effective at meeting RAOs. The potential for exposure to contaminants through inhalation, ingestion, and direct contact would be minimized under this alternative. Further, the potential for leaching of contaminants would be reduced by reducing infiltration of precipitation through the zone of contamination. The soil cover would be prone to erosion during Brandywine Creek flood events.

This alternative provides a high degree of short-term effectiveness, because contaminated material would not have to be disturbed during implementation; therefore, dust generation would be minimized.

4.2.3.3 Implementability

These measures are technically feasible and easily implementable with standard construction equipment and techniques. Long-term monitoring and maintenance would be required to ensure long-term effectiveness of the soil cover.

4.2.3.4 Cost

It is assumed that the State of Delaware will incur costs associated with long-term monitoring and maintenance; therefore, those costs are not included in this alternative. The present worth cost for Alternative 3 is estimated to be $70,000. The itemized cost estimate for this alternative is provided in Appendix A.

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4.2.4 Alternative 4 – Excavation and Off-site Subtitle C Landfill

The following sections describe and discuss the effectiveness, implementability, and costs associated with Alternative 4.

4.2.4.1 Description

Alternative 4 would involve the excavation of contaminated soil and debris associated with the 12th Street Landfill/Dump Site. The clean soil cover over the area of contamination would be removed, stockpiled, and replaced after backfilling. Excavation, backfill, and grading would be performed, using standard construction equipment consisting of backhoes, front-end loaders, and bulldozers. Dewatering, dust suppression, and air monitoring would be implemented, as necessary, during excavation. The excavation would be backfilled with imported fill material. The site would be contoured and revegetated to ensure proper drainage of runoff. Excavated material would be placed in dump trucks for overland hauling to a permitted, RCRA-compliant, Subtitle C (hazardous waste) landfill. If necessary, micro- or macro-encapsulation would be performed at the disposal facility to meet LDR treatment standards.

4.2.4.2 Effectiveness

This alternative would be protective of public health and the environment by removing contaminated soil from the site for off-site landfill disposal, thereby achieving a high degree of long-term effectiveness and permanence. RAOs would be met, and ARARs would be complied with; however, the CERCLA preference for destruction and volume reduction technologies over landfill disposal would not be satisfied. Post removal site control (PRSC) would not be required under this alternative.

Primary ARARs that would have to be attained for this alternative are the RCRA LDRs. Alternative LDR treatment standards have been promulgated, which allow less stringent treatment requirements for soil and debris contaminated with hazardous waste. The applicability of RCRA LDRs is dependent on the determination of RCRA hazardous waste codes through TCLP testing. For purposes of this EE/CA it is assumed, based on previous sampling data, that the excavated material will exhibit the RCRA characteristic of toxicity for arsenic (D004) and lead (D008). Under this alternative, treatment to attain the LDRs will be performed off site at the disposal facility.

No reduction in toxicity or volume of the waste would occur, although mobility would be reduced by encapsulation. As with any off-site disposal alternative, a risk of accidental release of contaminated material during transportation would exist. Dust control, air monitoring, and worker PPE would be used, as necessary, to minimize short-term impacts to workers and the community during implementation.

4.2.4.3 Implementability

Additional site characterization would be required to determine the extent of contamination that would require excavation. Because of the presence of contamination below the water table, dewatering would be required during excavation. Additional, site-specific hydrogeologic data would be required to properly design a dewatering system. Dewatering could be accomplished through a wellpoint dewatering system if hydraulic conductivities are relatively high, or through the use of sumps and pumps in the excavations if hydraulic conductivities are relatively low. Excavation and off-site disposal of contaminated soil and debris could be achieved with standard construction equipment upon final delineation of contaminated soil and debris.

This alternative would require an exemption to the $2-million statutory limit for removal actions; this exemption would have to be obtained for the 12th Street Landfill/Dump Site.

State and community acceptance will be evaluated in the Action Memorandum by EPA upon selection of the removal alternative.

4.2.4.4 Cost

The present worth cost for Alternative 4 is estimated to be $19,780,000. The itemized cost estimate for this alternative is provided in Appendix A.

4.2.5 Alternative 5 – Consolidation and Containment

The following sections describe and discuss the effectiveness, implementability, and costs associated with Alternative 5.

4.2.5.1 Description

Alternative 5 would include the consolidation of contaminated soil from areas that are not currently under the soil cover installed during the April 2000 EPA time-critical removal action. These soils would be contained with the soils under the soil cover. Containment under this alternative would be in the form of a low-permeability, engineered cover and a slurry wall vertical barrier encircling the site. The cover would be keyed into the slurry wall, and the slurry wall would be keyed into bedrock to contain the zone of contamination.

Numerous design variations are possible for the engineered cover; however, for the purposes of this analysis, the cover is assumed to be composed of 2 feet of compacted clay, with 6 inches of topsoil, to support the establishment of a vegetative layer. Clay installation would be tested to ensure conformance with strict specifications on compaction to achieve low permeability. The cover contours would be designed to promote drainage of storm water runoff, while minimizing erosion.

The vertical barrier would be installed using standard slurry wall construction techniques. In most formations, the trench excavation is supported, by keeping the hole filled with a viscous mixture of bentonite and water, termed "slurry". The slurry hydraulically shores the trench to prevent collapse and forms a filter cake to reduce groundwater flow. The bentonite slurry is used primarily for wall stabilization during trench excavation. The permanent membrane is formed using a mixture of the same slurry with soil to form a low-permeability barrier. Slurry walls are typically 2 to 4 feet thick, with depths up to 100 feet routinely achieved. By keying the slurry wall into the bedrock, leakage potential would be minimized.

PRSC measures under this alternative would include periodic monitoring and maintenance of the containment system integrity. Monitoring could be accomplished by visual inspection of the cover. Maintenance would include prevention of tree and shrub growth, repair of eroded areas, and reestablishment of vegetation, as needed. For the purposes of this EE/CA, it is assumed that all PRSC will be performed under state and local authority.

4.2.5.2 Effectiveness

This alternative provides protection of human health and the environment by effectively containing contaminants on site. LDRs would not be triggered, because "placement", as defined under RCRA, would not occur. RAOs would be achieved through reduction of contaminant mobility; however, no reduction of toxicity or volume would occur. Contaminants would remain on site, subject to potential impairment of the integrity of the containment structures in the long term under the effects of erosion, tree root growth, and human activities. PRSC, including periodic monitoring and maintenance, would be required to ensure long-term effectiveness

Short-term impacts would be minimal under this alternative, because most of the contaminated soil would remain in place. Some excavation and consolidation may occur if areas of contamination are identified outside of the current cover area; however, this is expected to be relatively minor. Measures would be implemented to ensure the protection of workers and the community from fugitive dusts during any excavation of contaminated soil.

4.2.5.3 Implementability

Installation of a compacted clay cap and slurry wall would be easily accomplished with standard construction equipment and techniques. The final delineation of contaminated soil and debris would have to be completed first, in order to identify any additional areas that would be consolidated under the cap.

4.2.5.4 Cost

It is assumed that the State of Delaware will incur costs associated with long-term monitoring and maintenance; therefore, those costs are not included in this alternative. The present worth cost for Alternative 5 is estimated to be $1,600,000. The itemized cost estimate for this alternative is provided in Appendix A.

4.2.6 Alternative 6 – Consolidation and Injection Stabilization

The following sections describe and discuss the effectiveness, implementability, and costs associated with Alternative 6.

4.2.6.1 Description

This alternative would involve the in situ treatment of wastes using S/S technology to immobilize contaminants. Several process options are available for implementation of in situ S/S. Auger systems are considered to be impractical for the 12th Street Landfill/Dump Site because of the presence of large quantities of debris. S/S processes involving the mixing of binders with the soil using heavy equipment can be effective means of reducing leachability; however, because such methods require effective mixing and contact with the entire mass of contaminated material, they would be logistically difficult and costly to implement. For the purposes of this EE/CA, injection stabilization will be the assumed technology for in situ treatment.

Injection stabilization (also known as pressure grouting) is an established technology, originally developed for improving physical properties of soil in the construction industry. The same technology has been successfully applied to hazardous waste sites to reduce the mobility of contaminants. Injection

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stabilization is accomplished by injecting a stabilizing agent (such as grout) into the soil under high pressure to reduce permeability, and therefore leachability, by filling voids. The injection point for soil consists of a perforated pipe with a conical point that is driven to the level at which the grout is to be injected. In hard soil, a hole is drilled to the grouting level. A grout pipe is sealed into the hole by an expanding gasket, or packer, just above the level to be grouted. The stabilizing agent is injected in a liquid state or in suspension, which subsequently solidifies or precipitates, creating a radial treatment zone around each injection hole. Specific materials used and spacing of injection holes are selected based on the physical characteristics of the area to be treated. Additional subsurface characterization and pilot tests would be required to properly design an injection stabilization program. Soil cores would be collected periodically between injection points during implementation to evaluate the effectiveness of treatment.

Under this alternative, no excavation of contaminated material would be required. The existing soil cover and vegetative layer would remain in place, with some disturbance caused by drilling and injection operations, which would be repaired upon completion.

4.2.6.2 Effectiveness

This alternative provides protection of human health and the environment by immobilizing contaminants in place. LDRs would not be triggered, because "placement", as defined under RCRA, would not occur. RAOs would be achieved through reduction of contaminant mobility, however, no reduction of toxicity or volume would occur. Contaminants would remain on site, subject to potential future exposure if the site is disturbed. PRSC, including monitoring and maintenance, would be recommended to ensure long-term effectiveness.

Short-term impacts would be minimal under this alternative, because most of the contaminated soil would remain in place. Some excavation and consolidation would be required for areas of contamination outside of the current cover area; however, this is expected to be relatively minor. Measures would be implemented to ensure the protection of workers and the community from fugitive dusts during any excavation of contaminated soil.

4.2.6.3 Implementability

The technical feasibility of this technology is dependent upon the physical characteristics of the contaminated zone. It is difficult to achieve penetration of stabilizing agents into very fine soils (silts and clays). In such cases, the fluid may tend to form irregular fingers and sheets that penetrate weaker seams and force them apart. Although all of the voids would not be filled in such a case, the process would probably achieve the desired result of reducing the overall permeability of the formation.

Injection stabilization is a highly specialized technology, requiring an intimate familiarity with the structure of the soil and a high degree of experience with the material, equipment, and procedures that might be used. Therefore, any injection stabilization program should be considered tentative and subject to revision, as work progresses. Services and materials to implement this alternative are readily available.

This alternative would require an exemption from the $2-million statutory limit for removal actions; this exemption would have to be obtained for the 12th Street Landfill/Dump Site.

4.2.6.4 Cost

It is assumed that the State of Delaware will incur costs associated with long-term monitoring and maintenance; therefore, those costs are not included in this alternative. Costs for this alternative are difficult to accurately predict without additional geotechnical characterization. In order to generate a preliminary cost estimate for the EE/CA, the following assumptions were made:

- The treatment zone is composed primarily of relatively permeable, medium-grained soils.
- One part slurry will treat 4 parts soil by volume.
- Injection stabilization cost will be $30.70 per cubic foot of slurry, based on average M.S. Means cost data.

Based on the above assumptions, the present worth cost for Alternative 6 is estimated to be $17,920,000. The itemized cost estimate for this alternative is provided in Appendix A.

4.2.7 Alternative 7 – Excavation, Debris Segregation, Solidification/Stabilization, and Off-site Subtitle D Landfill of Treated Soil and Debris

The following sections describe and discuss the effectiveness, implementability, and costs associated with Alternative 7.

4.2.7.1 Description

This alternative would involve the excavation of all contaminated soil and debris. The existing clean soil cover would be removed and reused as backfill. Excavated contaminated material would be processed through a screening system to segregate debris. Debris would be disposed of at an off-site, RCRA Subtitle D landfill or recycled if it has any scrap metal value. Soil would be processed on site through an S/S treatment system to achieve a reduction in leachability of lead and arsenic, as measured by TCLP. The goal of treatment would be to remove the RCRA toxicity characteristics by reducing TCLP concentrations of lead and arsenic to less than 5.0 mg/L. If successful, the treated soil would be classified as non hazardous and would be disposed of at a RCRA Subtitle D facility at a substantially lower cost than a RCRA Subtitle C facility.

Excavation, backfilling, and grading would be performed, using standard construction equipment consisting of backhoes, front-end loaders, and bulldozers. Dewatering, dust suppression, and air monitoring would be implemented, as necessary, during excavation. The excavation would be backfilled with imported fill material. The site would be contoured and vegetated to ensure proper drainage of runoff.

4.2.7.2 Effectiveness

Protection would be provided under this alternative by permanently removing all contaminated soil from the site, thereby achieving a high degree of long-term effectiveness and permanence. RAOs would be met, and LDRs would be complied with.

No reduction in toxicity or volume of the waste would occur, although mobility would be reduced by S/S treatment. As with any off-site disposal alternative, a risk of accidental release of contaminated material during transportation would exist. Excavation and implementation of the on-site S/S treatment would present short-term risks associated with fugitive dust. Dust control, air monitoring, and worker PPE would be used, as necessary, to minimize short-term impacts to workers and the community during implementation.

4.2.7.3 Implementability

The equipment and services required to implement this alternative are readily available and generally reliable for contaminants at the 12th Street Landfill/Dump Site; however, a treatability study would be recommended to determine whether the treatment goals are feasible for the site and to optimize the process design. The location of the site in a flood plain could cause temporary shutdowns during implementation. On-site treatment would result in an increase in the total weight and volume of material transported off site.

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This alternative would require an exemption from the $2-million statutory limit for removal actions; this exemption would have to be obtained for the 12th Street Landfill/Dump Site.

4.2.7.4 Cost

Costs for this alternative are difficult to accurately predict without treatability study data. In order to generate a preliminary cost estimate for the EE/CA, the following assumptions were made:

- S/S treatment will be capable of meeting TCLP criteria.
- Volume and mass increase from S/S treatment will be 30 percent.
- S/S processing cost will be $100 per cubic yard.
- Debris will be classified as non hazardous.

Based on the above assumptions, the present worth cost for Alternative 7 is estimated to be $15,940,000. The itemized cost estimate for this alternative is provided in Appendix A.

4.2.8 Alternative 8 – Excavation, Debris Screening, Soil Washing, Backfill of Clean Soil, Off-site Subtitle C Landfill of Contaminated Soil, and Off-site Subtitle D Landfill of Debris

The following sections describe and discuss the effectiveness, implementability, and costs associated with Alternative 8.

4.2.8.1 Description

This alternative would involve the excavation of all contaminated soil and debris. The soil cover would be removed and reused as backfill. Excavated, contaminated material would be processed through a screening system to segregate debris. Debris would be disposed of at an off-site, RCRA Subtitle D landfill or recycled if it has any scrap metal value. Soil would be processed on site through a soil washing system. Contaminants would be removed from the coarse-grained fraction of the soil and concentrated in the fine-grained fraction. The goal of treatment would be to reduce the volume of material requiring disposal by reducing total arsenic and lead concentrations in the coarse fraction so that it is suitable for backfill. The contaminated fine fraction would be disposed of at an off-site, RCRA Subtitle C landfill.

Excavation, backfill, and grading would be performed, using standard construction equipment consisting of backhoes, front-end loaders, and bulldozers. Dewatering, dust suppression, and air monitoring would be implemented, as necessary, during excavation. The excavation would be backfilled with treated soil and imported fill material. The site would be contoured to ensure proper drainage of storm water runoff and revegetated.

4.2.8.2 Effectiveness

Protection would be provided under this alternative by permanently removing all contaminated soil from the site, thereby achieving a high degree of long-term effectiveness and permanence. RAOs would be met and LDRs would be complied with.

No reduction in toxicity or mobility of the waste through treatment would occur, although the volume of material would be reduced by concentrating the contaminants. As with any off-site disposal alternative, a risk of accidental release of contaminated material during transportation would exist. Excavation and implementation of the on-site, soil washing treatment would present short-term risks associated with fugitive dust. Dust control, air monitoring, and worker PPE would be used, as necessary, to minimize short-term impacts to workers and the community during implementation.

4.2.8.3 Implementability

Equipment and services required to implement this alternative are readily available and reliable for contaminants at the 12th Street Landfill/Dump Site; however, a treatability study would be recommended to determine whether treatment goals are feasible for the site and to optimize the process design. The location of the site in a flood plain could cause temporary shutdowns during implementation. On-site treatment would result in a reduction of the total weight and volume of material transported off site.

This alternative would require an exemption from the $2-million statutory limit for removal actions.

4.2.8.4 Cost

Costs for this alternative are difficult to accurately predict without treatability study data. In order to generate a preliminary cost estimate for the EE/CA, the following assumptions were made:

- Soil washing treatment will be capable of meeting cleanup criteria for 90 percent of the soil treated.
- The soil washing processing cost will be $93.22 per ton, based on R.S. Means cost data.
- Debris will be classified as non hazardous.

Based on the above assumptions, the present worth cost for Alternative 8 is estimated to be $14,590,000. The itemized cost estimate for this alternative is provided in Appendix A.

5.0 COMPARATIVE ANALYSIS OF REMOVAL ACTION ALTERNATIVES

The alternatives described in Section 4.0 are compared in this section to evaluate their performance in relation to each of the criteria. The criteria used in this comparison are the same as in Section 4.0, namely effectiveness, implementability, and cost. Tables 5-1 and 5-2 compare the alternatives against the three criteria in a tabular format.

5.1 EFFECTIVENESS OF ALTERNATIVES

Alternatives 1 and 2 would not meet RAOs, specifically, for the newly identified area of contamination to the north of 12th Street. Alternative 2 would be slightly more effective than Alternative 1, NFA, by imposing deed notices and restrictions; however, leaching of contaminants to Brandywine Creek would continue, although significantly reduced by the current soil cover installed during the April 2000 time-critical removal action. Current analytical data (see Table 2-2) do not indicate that leaching from the site causes exceedances of water quality criteria designed for protection of aquatic organisms.

Alternative 3 (soil cover over contaminated areas) would provide a measure of effectiveness by reducing direct contact, ingestion, and inhalation threats and reducing the potential for leaching of contaminants to groundwater and surface water. This alternative could potentially achieve RAOs by reducing mobility of contaminants. It would provide a higher degree of short-term effectiveness than Alternatives 4 through 8, because contaminated soils would not be disturbed and it could be implemented quickly and easily. However, it would provide a lesser degree of long-term effectiveness, because contamination would remain in the subsurface, with no reduction of toxicity or volume and limited reduction of mobility.

Alternative 5 (consolidation and containment) and Alternative 6 (consolidation and injection stabilization) would provide similar levels of long-term effectiveness by decreasing mobility of contaminants to meet RAOs. These alternatives would be more effective than Alternatives 1, 2, and 3 but less effective than Alternatives 4, 7, and 8 in the long term. Alternative 5 would be slightly more effective than Alternative 6 in the long term, because it would be less dependent upon the site-specific subsurface geology, and it could be implemented in a more predictable and controlled manner. However, the clay cap under Alternative 5 would be subject to erosion, and tree root growth and would require long-term monitoring and maintenance to ensure effectiveness. Under ideal conditions, injection stabilization would permanently change the physical properties, including permeability, of the treatment zone; however, it is currently unknown whether this technology is suitable for the site.

Alternative 5 would be slightly more effective than Alternative 6 in the short term, because the implementation time would be considerably less. Short-term impacts during implementation would be minimal under either of these alternatives, because most of the contaminated soil would not be disturbed. Some excavation to consolidate areas of contamination would occur under both alternatives. In addition, Alternative 5 would involve excavation associated with slurry wall construction, thereby increasing short-term risks.

Alternatives 4, 7, and 8 provide the highest degree of long-term effectiveness by removing contaminants from the site to meet RAOs. Alternative 4 (Off-site Treatment and Landfill) and Alternative 7 (On-site S/S and Off-site Landfill) would achieve reductions in mobility of contaminants through treatment. Alternative 8 (Soil Washing and Off-site Landfill) would achieve a reduction in the volume of contaminated soil through on-site treatment and a reduction in mobility of contaminants through off-site treatment at the disposal facility prior to landfilling. These alternatives would have the highest potential for short-term impacts, because the entire volume of contaminated soil would be excavated and either treated on site or transported off site through the community. Potential short-term risks to workers and the community associated with fugitive dust, storm water runoff, and increased truck traffic would be addressed through appropriate control measures and monitoring. Alternatives 4 and 7 are virtually equal in terms of long-term effectiveness. Alternative 8 may be considered slightly less effective, because the washed soil that is backfilled may contain residual contamination; however, the concentrations would be reduced to levels that are considered to be protective of human health and the environment. Soil properties and contaminant concentration and distribution are the primary factors that will determine the effectiveness of injection stabilization, S/S, and soil washing. The effectiveness of injection stabilization is particularly difficult to monitor and control, because it is conducted in situ.

All of the alternatives would achieve an equal degree of compliance with ARARs.

5.2 IMPLEMENTABILITY OF ALTERNATIVES

Alternative 1 is the easiest to implement, because NFA would take place. Alternative 2 would be the next easiest to implement technically; however, deed restrictions and deed notices may prove administratively difficult to enforce in the long term. Alternative 3 would be next easiest to implement. Alternatives 4 and 5 would be more technically feasible to implement than Alternatives 6, 7, and 8, because they rely on well-established, readily available technologies that are not very sensitive to site-specific factors. Alternatives 6, 7, and 8 rely on technologies whose technical feasibility is subject to site-specific conditions and limitations. Some level of treatability evaluation would be recommended prior to full-scale implementation of any of these alternatives.

TABLE 5-1

COMPARATIVE ANALYSIS FOR NON EXCAVATION REMOVAL ACTION ALTERNATIVES 12TH STREET LANDFILL/DUMP SITE

Criteria	Alternative 1 No Further Action		Alternative 2 Institutional Controls		Alternative 3 Soil Cover		Alternative 5 Consolidation and Containment		Alternative 6 Injection Stabilization	
	Comment	Score	Comment	Score	Comment	Score	Comment	Score	Comment	Score
EFFECTIVENESS										
Overall Protection of Human Health and the Environment	No additional protection to human health or environment; contaminants of concern and potential for exposure remain.	1	Provides limited protection to human health and environment by warning prospective buyers and restricting development, but does not address leaching.	3	Provides protection to human health and environment by minimizing direct contact threat and reduces leachate generation by reducing surface infiltration.	4	Provides protection to human health and environment by minimizing migration of contaminants through containment measures.	6	Provides protection to human health and environment by immobilizing contaminants to meet RAOs.	6
Compliance with ARARs	ARARs would not be triggered.	5	ARARs would not be triggered.	5	RCRA requirements would not be triggered, because material would not be excavated.	6	RCRA requirements would not be triggered, because material would be consolidated within the area beneath the current soil cover.	8	RCRA requirements would not be triggered, because material would be treated in situ.	9
Short-term Effectiveness	No risk during implementation because NFA is taken.	10	No risk during implementation because NFA is taken.	10	Very low risk during implementation, because contaminated material is not disturbed.	9	Potential for worker exposure during consolidation and slurry trench excavation. RAOs would likely be achieved within 8 months.	7	Potential for worker exposure during consolidation; project duration would likely exceed 2 years.	6
Long-term Effectiveness and Permanence	Low; RAOs would not be met. Leaching of contaminants would continue.	1	Very limited; RAOs would not be met. Leaching of contaminants would continue.	2	Effectively reduces direct contact threat; provides some reduction of contaminant leaching by reducing infiltration. Contaminants remain.	5	Effectively minimizes leaching of contaminants. RAOs would be met.	7	Potentially effective in the long-term assuming uniform distribution throughout the subsurface; however, highly dependent on site-specific geology.	6
Reduction in Toxicity, Mobility, and Volume through Treatment	No further reduction in toxicity, mobility, or volume through treatment.	1	No reduction in toxicity, mobility, or volume through treatment.	1	Contaminants are not treated; however, mobility is reduced through containment.	5	Contaminants are not treated; however, mobility is reduced through containment.	6	Mobility of contaminants would be significantly reduced through treatment.	9

TABLE 5-1 (Continued)

COMPARATIVE ANALYSIS SUMMARY FOR NON EXCAVATION REMOVAL ACTION ALTERNATIVES
12TH STREET LANDFILL/DUMP SITE

Criteria	Alternative 1 No Further Action		Alternative 2 Institutional Controls		Alternative 3 Soil Cover		Alternative 5 Consolidation and Containment		Alternative 6 Injection Stabilization	
	Comment	Score	Comment	Score	Comment	Score	Comment	Score	Comment	Score
IMPLEMENTABILITY										
Technical Implementability	Readily implementable.	10	Implementable, but deed restrictions are administratively difficult to enforce.	7	Implementable with readily available equipment and techniques in a short timeframe with little planning.	9	Implementable with readily available equipment and techniques.	8	Soil property testing and possibly a pilot study would be required to evaluate technical feasibility.	5
Community and Regulatory Acceptance	Regulatory acceptance is unlikely.	1	Community and regulatory acceptance would probably be low; leaching of contaminants would continue.	4	Regulators and the community would likely accept this technology if leaching of contaminants is found to be minimal.	7	Regulators and the community would likely accept this technology, because it is well demonstrated.	8	Regulators and the community would potentially accept this technology if effectiveness was demonstrated.	
COST										
Estimated Cost	$0	10	< $1,000	9	$70,000	9	$1,600,000	8	$17,900,000	2
Overall Ranking		39		41		54		58		49

Notes:

ARAR	Applicable or relevant and appropriate requirement
NFA	No further action
RAO	Removal action objective
RCRA	Resource Conservation and Recovery Act

TABLE 5-2

COMPARATIVE ANALYSIS SUMMARY FOR EXCAVATION REMOVAL ACTION ALTERNATIVES
12TH STREET LANDFILL/DUMP SITE

Criteria	Alternative 4 Off-site Landfill		Alternative 7 Ex Situ S/S and Off-site Disposal		Alternative 8 Soil Washing	
	Comment	Score	Comment	Score	Comment	Score
EFFECTIVENESS						
Overall Protection of Human Health and the Environment	Provides high degree of protection by removing all contaminated soil and debris from site.	9	Provides high degree of protection by removing all contaminated soil and debris from site.	9	Provides protection to human health and environment by removing contaminants from soil for off-site disposal.	9
Compliance with ARARs	RCRA LDRs and hazardous materials transportation ARARs would apply and be complied with.	7	If toxicity characteristics can be removed through on-site treatment, RCRA hazardous waste requirements would not apply.	7	RCRA LDRs and hazardous materials transportation requirements would apply and be complied with regarding contaminated soil fraction of the waste stream.	7
Short-term Effectiveness	Potential for worker exposure during excavation operations. Risk associated with transport of contaminated material through the community and increased traffic for backfill hauling. RAOs would likely be achieved within 1 year.	5	Potential for worker exposure during excavation and treatment operations exists. Risk associated with transport of contaminated material through the community and increased traffic for backfill hauling. RAOs would likely be achieved within 2 years.	5	Potential for worker exposure during excavation and treatment. Lower risk is associated with transportation than Alternatives 3 and 7, because volume is greatly reduced. RAOs would likely be achieved within 2 years.	5
Long-term Effectiveness	Highly effective and permanent, because sources would be removed.	10	Highly effective and permanent, because sources would be removed from the site; however, the ability of S/S to reach treatment goals is uncertain.	8	Highly effective and permanent, assuming treatment goals are achieved.	8
Reduction in Toxicity, Mobility, and Volume through Treatment	No reduction in toxicity or volume through treatment would occur; however, off-site treatment to meet LDRs would reduce mobility.	7	Mobility would be reduced through on-site treatment with associated volume increase.	8	Volume of contaminants would be significantly reduced through treatment. Off-site treatment of contaminated soil would reduce mobility.	8
IMPLEMENTABILITY						
Technical Implementability	Readily implementable, but dependent on capacity of Subtitle C landfills.	8	Technical feasibility would need to be further evaluated through a treatability study to determine capability and cost of treatment.	4	Further site-specific evaluation of this technology is required to determine capability and cost of treatment.	4
Community and Regulatory Acceptance	Heavy truck traffic associated with this alternative may be objectionable to the community.	5	Heavy truck traffic associated with this alternative may be objectionable to the community.	5	Community and regulatory acceptance is likely if effectiveness can be demonstrated.	7
COST						
Estimated Cost	$19,800,000	1	$15,900,000	3	$14,600,000	3
Overall Ranking		52		46		51

Notes:

ARAR	Applicable or relevant and appropriate requirement
LDR	Land disposal restriction
RAO	Removal action objective
RCRA	Resource Conservation and Recovery Act
S/S	Solidification/stabilization

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5.3 COST OF ALTERNATIVES

Costs are difficult to accurately predict for Alternatives 6, 7, and 8 without the benefit of site-specific treatability data and more in-depth site characterization. Soil properties and contaminant concentration and distribution are the primary factors that will affect the cost of these technologies. Based on the assumptions presented in the cost estimates prepared for this EE/CA, the costs for each alternative in increasing order are as follows:

- Alternative 1 – NFA: **No cost**
- Alternative 2 – ICs: **< $1000**
- Alternative 3 – Soil Cover Over Contaminated Areas: **$70,000**
- Alternative 5 – Consolidation and Containment: **$1.6 million**
- Alternative 8 – Excavation, Debris Screening, Soil Washing, Backfill of Clean Soil, Off-site Encapsulation and Subtitle C Landfill of Contaminated Soil, and Off-site Subtitle D Landfill of Debris: **$14.6 million**
- Alternative 7 – Excavation, Debris Screening, On-site S/S, and Off-site Subtitle D Landfill of Treated Soil and Debris: **$15.9 million**
- Alternative 6 – Consolidation and Injection Stabilization **$17.9 million**
- Alternative 4 – Excavation and Off-site Subtitle C Landfill: **$19.8 million**

PRSC costs, which would apply to Alternatives 1, 2, 3, 5, and 6, are not included in the cost estimates, based on the assumption that long-term monitoring and maintenance costs will be assumed by another party.

6.0 RECOMMENDED REMOVAL ACTION ALTERNATIVE

This EE/CA was prepared in accordance with current EPA guidance documents for non time-critical removal actions under CERCLA. The purpose of this EE/CA was to identify and analyze alternative RAs to address lead and arsenic contamination associated with unauthorized industrial dumping at the 12th Street Landfill/Dump Site. Eight alternatives were identified, evaluated, and ranked: (1) NFA; (2) ICs; (3) soil cover over contaminated areas; (4) excavation and off-site disposal; (5) on-site containment (6) injection stabilization; (7) excavation, on-site S/S, and off-site disposal; and (8) excavation, on-site soil washing, and backfilling.

Based on the comparative analyses of RA alternatives completed in Section 5.0, the recommended RA is Alternative 5, consolidation and on-site containment, for minimizing migration of contaminants to groundwater and surface water. However, if leaching of contaminants from groundwater to Brandywine Creek is not found to exceed risk-based concentrations for site-related contaminants, then Alternative 3, soil cover over contaminated areas, may provide an acceptable degree of protection at a minimal cost. Soil cover has already been established over the primary area of contamination. Under this alternative, soil cover would be placed over the newly identified area of contamination across 12th Street to the north of the site. Current analytical data indicate that site contaminants indeed leach from the site, but do not cause concentrations to exceed water quality criteria designed for protection of aquatic organisms.

Containment was the technology chosen, because it best meets the NCP criteria of overall protectiveness of human health; compliance with ARARs; long-term effectiveness; reduction of mobility, toxicity, or volume through treatment; short-term effectiveness; implementability; and cost. State and community acceptance will be evaluated by EPA and addressed, as necessary, in the Action Memorandum.

Alternatives 4, 7, and 8 may provide greater long-term effectiveness and permanence by removing all contaminated material from the site; however, the increased long-term effectiveness must be weighed against the increased short-term risks and greatly increased costs associated with excavation, treatment, and transportation of the contaminated material. Alternative 6, injection stabilization, achieves a similar level of short- and long-term effectiveness; however, it would be much more costly and has greater uncertainties associated with implementation.

7.0 REFERENCES

Delaware Department of Natural Resources and Environmental Control (DNREC). 2000a. Letter from Ann L. Breslin, Project Officer. To Michael T. Towle, Federal On-Scene Coordinator, EPA Region III-Removal Branch. Regarding 12th Street Drum (Dump) Site DE-294: ARARs and Sensitive Environments/Endangered Species. March 8.

DNREC. 2000b. "Diamond State Foundry/Pullman Palace Car Works Final Brownfield Preliminary Assessment II". September.

Federal Emergency Management Agency. 2000. Flood Insurance Rate Map, New Castle County, Delaware (Panel 160 of 450). October.

Roy F. Weston, Inc. (Weston). 2000. "Trip Report for the 12th Street Landfill Site". Federal Programs Division. May 12.

Sundstrom, R.W., and T.E. Pickett. 1971. "The Availability of Groundwater in New Castle County, Delaware". Water Resources Center. University of Delaware. July.

PFE ORIGINAL

Tetra Tech EM Inc. (Tetra Tech). 2001. "Trip Report for 12th Street Landfill/Dump Site". March 26.

U.S. Environmental Protection Agency (EPA). 1988. "CERCLA Compliance with Other Laws Manual Draft Guidance". August.

EPA. 1989a. "CERCLA Compliance with Other Laws Manual, Part II, Clean Air Act and Other Environmental Statutes and State Requirements Interim Final". August.

EPA. 1989b. Letter from Henry L. Longest II, Director, Office of Emergency and Remedial Response to Directors I-X Regarding Interim Guidance on Establishing Soil Lead Cleanup Levels at Superfund Sites. September 7.

EPA. 1990a. "Engineering Bulletin – Solvent Extraction Treatment". EPA/540/2-90/013. Office of Research and Development (ORD). Cincinnati, Ohio. September.

EPA. 1990b. "Engineering Bulletin – Soil Washing Treatment". EPA/540/2-90/017. ORD. Cincinnati, Ohio. September.

EPA. 1990c. "Superfund LDR Guide #6B, Obtaining a Soil and Debris Treatability Variance for Removal Actions". Superfund Publication 9347.3-06BFS. September.

EPA. 1993. "Guidance on Conducting Non-Time-Critical Removal Actions Under CERCLA". August.

EPA. 1994. Letter from Elliott P. Laws, Assistant Administrator to Regional Administrators I-X Regarding Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities. July 14.

EPA. 1999a. Aerial Photographic Analysis, Wilmington Drum Site. Environmental Sciences Division. April.

EPA. 1999b. "National Recommended Water Qualilty Criteria – Correction". April.

EPA. 2000a. Letter from Michael Towle, On-Scene Coordinator. To Ms. Ann Breslin, Delaware Department of Natural Resources and Environmental Control. Regarding 12th Street Landfill/Dump Site. February 22.

EPA. 2000b. Letter from Abraham Ferdas, Director, Hazardous Waste Cleanup Division. To Timothy R. Fields, Assistant Administrator, Office of Solid Waste and Emergency Response. Regarding Approval of a Request for Removal Action at the 12th Street Landfill/Dump Site. March 13.

EPA. 2000c. 12th Street Landfill/Dump Site. Site File (Maintained Since Removal Action was Initiated in April 2000).

EPA. 2000d. "EPA Region III Risk-based Concentration Table". October 5.

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APPENDIX A

COST ESTIMATES

(13 pages)

BASIS FOR COST ESTIMATE

The following assumptions and data are used as a basis for the cost estimates for various alternatives for the 12th Street Landfill/Dump Site engineering evaluation/cost analysis (EE/CA).

1. Costs are estimated based on R.S. Means 1996 Environmental Restoration Unit Cost Book, unless otherwise noted.
2. R.S. Means cost estimating data are used for much of the estimate line items; Means reference numbers are provided for those items.
3. Certain items (for example, mobilization and demobilization, dust control, health and safety monitoring) are explicitly priced; these items are noted as "derived-x" on the summary sheets and cross-referenced on the work sheets.
4. Certain Means costs are adjusted either upward or downward, based on judgmental considerations. These adjustments take into account such factors as difficulty, size, excessive waste, and repetition. Adjustment factors are indicated on the work sheets.
5. The assumptions and calculations for derived cost items are shown on the respective work sheets for those items.
6. Dust control is assumed to be primarily by means of water spray using water tankers.
7. A unit weight of 3,000 pounds per cubic yard is used for conversion between soil weights and volumes.
8. A swell factor of 30 percent is used for conversion between bank measure and loose measure volumes.
9. Line item costs, as presented in the summary sheets, are for direct costs only. Overhead and profit are added as a separate line item at the bottom of these sheets.
10. Other alternative-specific assumptions are indicated on the worksheets, as necessary.

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QUANTITIES

SOIL AREAS, VOLUMES, AND MASS (BASED ON ESTIMATED AVERAGE 10- FOOT DEPTH)

Soil and Debris	AREA		VOLUME	MASS
Under Cover	Acres	SF	CY	Tons
Soil	3.62	157,500	52,500	78,750
Debris			5,833	8,750
Total	3.62	157,500	58,333	87,500

Other Areas	AREA		VOLUME	MASS
of Contamination	Acres	SF	CY	Tons
Soil	0.23	10,000	1,667	2,500
Debris			185	278
Total	0.23	10,000	1,852	2,778

Other	AREA		VOLUME	MASS
Material	Acres	SF	CY	Tons
Soil Cover	3.62	157,500	11,667	17,500

Notes:

CY Cubic yard(s)
SF Square Feet

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DERIVED COST DC01 - Field Overhead and Mobilization/Demobilization

Field Overhead

means reference	description	quantity	unit	unit cost	cost
99-04-1301	watchman service	8,760	hour	$7.80	$68,328
99-14-0103	office trailer 50'x10'	12	month	$343.11	$4,117
99-14-0201	storage van 16'x8'	12	month	$76.49	$918
010-034-0100	office equipment rental	12	month	$151.00	$1,812
010-034-0120	office supplies	12	month	$271.00	$3,252
010-034-0140	telephone	12	month	$253.00	$3,036
010-034-0160	office lights & hvac	12	month	$84.00	$1,008
99-11-0301	field personnel, clerk	52	week	$280.00	$14,560
99-11-0402	field personnel, fld eng.	52	week	$875.20	$45,510
99-11-0102	field personnel, pm	52	week	$1,420.00	$73,840
99-11-0202	field personnel, super	0	week	$1,340.00	$0
99-01-0601	traffic control laborers (2)	104	week	$914.00	$95,056
99-04-1201	surveying crew for line and grade	130	day	$759.08	$98,680
99-04-0501	portable chemical toilet 2ea	24	month	$78.31	$1,879
	total annual field overhead costs				$411,996
	monthly cost for field overhead			***DC01-A***	**$34,330**

Mobilize and Demobilize

Mobe/Demobe Labor
Assume that this cost is equivalent to 1 weeks of the excavation labor costs
5 days/week
8 hours/day
40 hours of excavation labor costs

	Crews	Equiv. Crew-hours	Cost/ crew-hour	Equivalent Cost
Soil Excavation (B-12B)	2	40	$392.00	$31,360.00
Backfill (B-10B)	1	40	$286.00	$11,440.00
Subtotal				$42,800.00

Mobe/Demobe equipment
2 Cat D6H Dozers
2 cat 235 Backhoes
2 Misc. pieces @

$250.00x 2 (each way) $3,000.00

167-130-0040	temp pwr 200 amp service	1 ea	$914.00	$914
Assumed	Work plan/ HASP Submittal	1 ea	$5,000.00	$5,000
see above	mobe/demobe labor	1 LS		$42,800
see above	mobe/demobe equip.	1 LS		$3,000
	total mobilization/demobilization costs		***DC01-B***	**$51,714**

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DERIVED COSTS DC02

DERIVED COSTS FOR EARTHWORK

Excavate, Stockpile, and Backfill Soil Cover

Reference	Description	Daily Output	Unit	Unit Cost	
02315-410-5420	Bulk w/ 300HP Dozer, 300' Haul	410	CY	4.03	(includes 15% for
02315-505-0170	2.5CY F.E. Loader, spread stockpile, 300'	600	CY	2.55	truck loading)
02315-505-0190	300HP Dozer, 300' Haul, Common Fill	600	CY	3.11	
02315-300-6050	Towed Sheepsfoot, 12" lifts, 2 passes	6,000	CY	0.20	
		TOTAL COST/CY		9.89	DC02a

On-site Consolidation of Contaminated Material

Reference	Description	Daily Output	Unit	Unit Cost	
02315-410-5420	Bulk w/ 300HP Dozer, 300' Haul	410	CY	5.55	(includes 15% for
02315-505-0170	2.5CY F.E. Loader, spread stockpile, 300'	600	CY	3.54	truck loading)
02315-505-0190	300HP Dozer, 300' Haul, Common Fill	600	CY	4.29	
02315-300-6050	Towed Sheepsfoot, 12" lifts, 2 passes	6,000	CY	0.28	
		TOTAL COST/CY		13.66	DC02f

Excavate and Haul Contaminated Soil to On-site Treatment Unit

Reference	Description	Daily Output	Unit	Unit Cost	
02315-400-0250	Excavate Bank Stockpile, 1.5CY Backhoe	800	CY	2.02	
	add 15% for Truck Loading			0.30	
02320-200-0320	12CY Dump Truck, 1/2 mile R.T.	250	CY	5.17	
		TOTAL COST/CY		7.49	DC02b

Excavate Contaminated Soil and Load Trucks for Off-site Disposal

Reference	Description	Daily Output	Unit	Unit Cost	
02315-400-0250	Excavate Bank Stockpile, 1.5CY Backhoe	800	CY	2.02	
02315-400-1600	Wheel mtd. FE loader, 21/4 cy	800	CY	1.42	
	add 15% for Truck Loading			0.21	
		TOTAL COST/CY		3.44	DC02g

Backfill and Compact Excavation with Imported Fill

Reference	Description	Daily Output	Unit	Unit Cost	
02315-505-0190	300HP Dozer, 300' Haul, Common Fill	600	CY	3.11	
02315-505-0170	2.5CY F.E. Loader, spread stockpile, 300'	600	CY	2.55	
17-03-0424	Unclassified fill, delivered, off-site	N/A	CY	5.00	
02315-300-6050	Towed Sheepsfoot, 12" lifts, 2 passes	6,000	CY	0.20	
		TOTAL COST/CY		10.87	DC02c

Backfill and Compact Excavation with Treated Soil

Reference	Description	Daily Output	Unit	Unit Cost	
02320-200-0320	12CY Dump Truck, 1/2 mile R.T.	250	CY	2.87	
02315-505-0190	300HP Dozer, 300' Haul, Common Fill	600	CY	2.39	
02315-300-6050	Towed Sheepsfoot, 12" lifts, 2 passes	6,000	CY	0.20	
		TOTAL COST/CY		5.47	DC02d

Consolidate Soil from Slurry Wall Excavation under Cover

Reference	Description	Daily Output	Unit	Unit Cost	
02315-505-0190	300HP Dozer, 300' Haul, Common Fill	600	CY	4.29	
02315-300-6050	Towed Sheepsfoot, 12" lifts, 2 passes	6,000	CY	0.28	
		TOTAL COST/CY		4.57	DC02e

DERIVED COST DC14

Costs to control dust using water tankers and water spray

1 water tanker operation

Hours per month for water tanker crew = 173 crew hours 8 hours/day 5 days/week

Labor

	$/man hour	$/hour	hours	Cost
1 Laborers	$20.87	$20.87	173	$3,610.78
1 Teamster	$21.05	$21.05	173	$3,641.55
2 persons				$7,252.33

346 Mh/month **$41.92/crew hour of labor**

Equipment		Operate $/hour	Rent $/month	No. hrs	No. mths	
1 Water Tanker *	2500 gal	$6.90	$1,482.00	173	1	$2,675.70
1 1/2" gas pump w/ hose & 1 sprayer **		$0.41	$245.00	173	1	$315.93
Subtotal						$2,991.63

$17.29 /crew hour of equipment

1 Crew+equip cost: $59.21 per crew hour

Materials & Supplies

	Usage for each crew:		use /month	Cost/ unit	Cost
PPE		man hour	346	$1.00	$346.00
ST&S		man hour		$0.50	$0.00
Water usage @loads/truck/day	2	1000gals	108	$2.00	$216.00
Materials & Misc. - per crew					$50.00
Subtotal, direct cost for dust control					**$612.00**

Cost per month, for 1 dust control crew **$10,900** **DC14-A**

NOTES:

* Source is the Blue Book Rental Rates.

** Source is Means reference 016-420-4100

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DERIVED COST DC13
Cost of Health and Safety Monitoring

Assume that 1 full-time health and safety technician is responsible for monitoring for compliance with dust control requirements, and general worker safety concerns.

Labor Cost per Month

	$/mh	Cost per Crew hr	hours	Cost
1 Techn.	$30.70	$30.70	173	$5,321
1 persons				$5,321

Equipment	Assumed Operate $/hr	Rent $/month **
1 TVA	$0.50	$1,426.00
4 Minirams	$0.00	$420.00
4 Sampler-personal pump	$0.13	$115.00
Subtotal		$1,961.00

Total Labor and Equipment **$7,282.00**

Analytical	Quantity	Unit	Cost/Unit	Cost
Samples-initial (4/dy*10dys)	40	ea	$130.81	$5,232.40
Samples-periodic (4/dy*50dys)	200	ea	$130.81	$26,162.00
Total, H & S Sampling				$31,394.40

DC-13A will equal Labor and Equipment Costs + H&S Sampling costs/ Duration of Alternative.

** Rental rates based on Total Safety, Inc., equipment rate list 2001

REFERENCE COSTS

Based on R.S. Means 2001 Site Work and Landscaping and 2001 Environmental Remediation Cost Data
(Other costs based on EPA Cleanup Information (CLU-IN) website cost data as indicated)

		Daily output	unit	cost	Safety-adjusted cost Level D	Safety-adjusted cost Level C
Excavation 02315	add 15% for truck loading					
02315-400-0250	Stockpiled for Loading 1.5CY backhoe	800	CY	1.31	1.44	2.02
02315-410-5220	Bulk w/ 300HP Dozer, 150' Haul	800	CY	1.70	1.79	2.47
02315-410-5420	Bulk w/ 300HP Dozer, 300' Haul	410	CY	3.32	3.50	4.82
02315-400-1600	Wheel mtd. FE loader, 21/4 cy	800	CY	0.91	1.00	1.42
17-03-0277	2 CY Excavator, Excavate & Load	600	CY	2.14	2.30	3.20
Dewatering						
17-03-1003	3" trash pump, 150 GPM (6 units)		mo	6142	6376	7014
				(assume 6 needed during excavation)		
Hauling						
02320-200-0320	12CY Dump Truck, 1/2 mile R.T.	250	CY	2.70	2.87	3.97
Backfill						
02315-505-0190	300HP Dozer, 300' Haul, Common Fill	600	CY	2.27	2.39	3.30
17-03-0424	Unclassified fill, delivered, off-site	N/A	CY	5.00	5.00	5.00
02315-505-0170	2.5CY F.E. Loader, spread stockpile, 300'	600	CY	1.84	1.96	2.72
Compaction						
02315-300-6050	Towed Sheepsfoot, 12" lifts, 2 passes	6,000	CY	0.19	0.20	0.28
Seeding						
02920-510-3500	Rye 10#/MSF Hydro/ Air Spread w/ Mulch	80	MSF	41.50	43.19	50.23
Capping						
33-08-0507	Clay 10E-7, 6" lifts	300	CY	18.63	19.66	24.99
Slurry Wall						
EPA CLU-IN	Soil-bentonite wall in medium soil	135	sf	8.00	NA	NA
				(1991 price adjusted for inflation)		
Injection Stabilization						
02250-050-0200	Cement grout	175	cf	30.70	32.19	37.03
				(average of minimum and maximum outputs)		
Debris Screening						
17-03-9901	Wash/Screen plant	1000	tons	2.94	3.18	4.45
Ex Situ S/S						
EPA CLU-IN		130	CY	100.00	NA	NA
				(assume 30% volume increase)		
Soil Washing						
33-13-0912	Treat > 60 tons soil including resid. water	160	ton	91.03	91.49	93.22
				(assume concentration on 10% fines)		
Transportation to disposal facility						
02100-300-1260	Truckload = 25 CY or 18 tons	N/A	mile	3.15	NA	NA
				(average of minimum and maximum costs)		

REMOVAL ACTION COST ANALYSIS
ALTERNATIVE 3
SOIL COVER OVER CONTAMINATED AREAS
12TH STREET LANDFILL/DUMP SITE
WILMINGTON, NEW CASTLE COUNTY, DELAWARE

Capital Costs					
Item Description	**Quantity**	**Unit**	**Cost/Unit**	**Factor ***	**Cost ****
Direct Capital Costs					
Field Overhead	1	month	$34,330.00	1	$19,353
Mobilization/Demobilization	1	lump sum	--	0.5	$25,857
Silt Fencing	500	linear foot	$0.68	1	$340
Place and Remove Hay Bales	3	ton	$287.50	1	$863
Install Soil Cover	741	cubic yard	$10.87	1	$8,049
Seed/Mulch/Fertilizer (Hydroseed)	10	MSF	$41.50	1	$415
Subtotal Direct Capital Costs					$54,877
Overhead and Profit (10%)					$5,488
Total Direct Capital Costs (Rounded to Nearest $10,000)					$60,000
Contingency Allowance (15%)					$9,000
Total Capital Costs (Rounded to Nearest $10,000)					***$70,000***

Notes:

* The factors represent adjustments for difficulty, size, and other intangibles that will affect the work.
** As a result of rounding, the amount in the Cost column may be slightly different than the product of the values in the Quantity, Cost/Unit, and Factor columns.
MSF = 1,000 square feet
-- = Not applicable

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REMOVAL ACTION COST ANALYSIS
ALTERNATIVE 4
EXCAVATION AND OFF-SITE DISPOSAL
12TH STREET LANDFILL/DUMP SITE
WILMINGTON, NEW CASTLE COUNTY, DELAWARE

Capital Costs					
Item Description	**Quantity**	**Unit**	**Cost/Unit**	**Factor ***	**Cost ****
Direct Capital Costs					
Health and Safety Monitoring	8	month	$11,301.47	1	$88,271
Dust Control	8	month	$10,900.00	1	$85,135
Field Overhead	8	month	$34,330.00	1	$268,137
Mobilization/Demobilization	1	lump sum	--	1	$51,714
Silt Fencing	2,500	linear foot	$0.68	1	$1,700
Place and Remove Hay Bales	16	ton	$287.50	1	$4,600
Excavate, Stockpile, and Backfill Soil Cover	11,667	cubic yard	$9.89	1	$115,392
Excavate and Load Contaminated Soil	60,185	cubic yard	$3.44	1	$207,037
Excavation Dewatering	8	month	$6,141.76	1	$50,545
Transportation to Disposal Facility	1,504,630	loaded mile	$3.15	1	$4,739,583
Treatment and Disposal of Contaminated Soil at Subtitle C Landfill	90,278	ton	$105.00	1	$9,479,167
Backfill with Common Fill and Compaction	48,519	cubic yard	$10.87	1	$527,192
Seed/Mulch/Fertilizer (Hydroseed)	168	MSF	$41.50	1	$6,951
Confirmation Soil Samples/Analysis	67	each	$100.00	1	$6,700
Subtotal Direct Capital Costs					$15,632,124
Overhead and Profit (10%)					$1,563,212
Total Direct Capital Costs (Rounded to Nearest $10,000)					$17,200,000
Contingency Allowance (15%)					$2,580,000
Total Capital Costs (Rounded to Nearest $10,000)					***$19,780,000***

Notes:

* The factors represent adjustments for difficulty, size, and other intangibles that will affect the work.
** As a result of rounding, the amount in the Cost column may be slightly different than the product of the values in the Quantity, Cost/Unit, and Factor columns.
MSF = 1,000 square feet
-- = Not applicable

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REMOVAL ACTION COST ANALYSIS ALTERNATIVE 5 CONSOLIDATION AND CONTAINMENT 12TH STREET LANDFILL/DUMP SITE WILMINGTON, NEW CASTLE COUNTY, DELAWARE					
Capital Costs					
Item Description	**Quantity**	**Unit**	**Cost/Unit**	**Factor ***	**Cost ****
Direct Capital Costs					
Health and Safety Monitoring	8	month	$11,162.13	1	$90,314
Dust Control	8	month	$10,900.00	1	$88,193
Field Overhead	8	month	$34,330.00	1	$277,767
Mobilization/Demobilization	1	lump sum	--	1	$51,714
Silt Fencing	2,500	linear foot	$0.68	1	$1,700
Place and Remove Hay Bales	16	ton	$287.50	1	$4,600
Remove, Stockpile, and Replace Soil Cover	11,667	cubic yard	$9.89	1	$115,392
Consolidate Contaminated Soil	1,852	cubic yard	$9.89	1	$18,316
Backfill with Common Fill and Compaction	2,407	cubic yard	$10.87	1	$26,158
Construct Clay Cap	11,667	cubic yard	$18.63	1	$217,350
Construct Slurry Wall	37,000	square feet	$8.00	1.2	$355,200
Consoidate Material Excavated for Slurry Wall	1,370	cubic yard	$4.57	1	$6,263
Seed/Mulch/Fertilizer (Hydroseed)	168	MSF	$41.50	1	$6,951
Subtotal Direct Capital Costs					$1,259,918
Overhead and Profit (10%)					$125,992
Total Direct Capital Costs (Rounded to Nearest $10,000)					$1,390,000
Contingency Allowance (15%)					$208,500
Total Capital Costs (Rounded to Nearest $10,000)					***$1,600,000***

Notes:

* The factors represent adjustments for difficulty, size, and other intangibles that will affect the work.
** As a result of rounding, the amount in the Cost column may be slightly different than the product of the values in the Quantity, Cost/Unit, and Factor columns.
MSF = 1,000 square feet
-- = Not applicable

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REMOVAL ACTION COST ANALYSIS ALTERNATIVE 6 CONSOLIDATION AND INJECTION STABILIZATION 12TH STREET LANDFILL/DUMP SITE WILMINGTON, NEW CASTLE COUNTY, DELAWARE					
Capital Costs					
Item Description	**Quantity**	**Unit**	**Cost/Unit**	**Factor ***	**Cost ****
Direct Capital Costs					
Health and Safety Monitoring	28	month	$8,406.43	1	$234,710
Dust Control	28	month	$10,900.00	1	$304,331
Field Overhead	28	month	$34,330.00	1	$958,502
Mobilization/Demobilization	1	lump sum	--	3	$155,142
Silt Fencing	500	linear foot	$0.68	1	$340
Place and Remove Hay Bales	3	ton	$287.50	1	$863
Consolidate Contaminated Soil	1,852	cubic yard	$9.89	1	$18,316
Backfill with Common Fill and Compaction	1,852	cubic yard	$10.87	1	$20,122
Injection Stabilization (assume 1cf slurry treats 4 cf soil)	406,250	cubic foot	$30.70	1	$12,471,875
Seed/Mulch/Fertilizer (Hydroseed)	10	MSF	$41.50	2	$830
Subtotal Direct Capital Costs					$14,165,031
Overhead and Profit (10%)					$1,416,503
Total Direct Capital Costs (Rounded to Nearest $10,000)					$15,580,000
Contingency Allowance (15%)					$2,337,000
Total Capital Costs (Rounded to Nearest $10,000)					***$17,920,000***

Notes:

* The factors represent adjustments for difficulty, size, and other intangibles that will affect the work.
** As a result of rounding, the amount in the Cost column may be slightly different than the product of the values in the Quantity, Cost/Unit, and Factor columns.
MSF = 1,000 square feet
-- = Not applicable

BEST ORIGINAL

REMOVAL ACTION COST ANALYSIS
ALTERNATIVE 7
EXCAVATION, DEBRIS SCREENING, ON-SITE S/S, AND OFF-SITE DISPOSAL
12TH STREET LANDFILL/DUMP SITE
WILMINGTON, NEW CASTLE COUNTY, DELAWARE

Capital Costs

Item Description	Quantity	Unit	Cost/Unit	Factor *	Cost **
Direct Capital Costs					
Health and Safety Monitoring	21	month	$8,744.48	1	$187,714
Dust Control	21	month	$10,900.00	1	$233,985
Field Overhead	21	month	$34,330.00	1	$736,945
Mobilization/Demobilization	1	lump sum	--	5	$258,570
Silt Fencing	2,500	linear foot	$0.68	1	$1,700
Place and Remove Hay Bales	16	ton	$287.50	1	$4,600
Excavate, Stockpile, and Backfill Soil Cover	11,667	cubic yard	$9.89	1	$115,392
Excavate and Haul Contaminated Soil to Treatment Unit	60,185	cubic yard	$7.49	1	$450,896
Debris Screening	90,278	ton	$4.45	1	$401,340
Solidification/Stabilization Treatment	54,167	cubic yard	$100.00	1	$5,416,667
Transportation to Disposal Facility	176,042	loaded mile	$3.15	1	$554,531
Disposal of Treated Soil and Debris at Subtitle D Landfill	105,625	ton	$35.00	1	$3,696,875
Backfill with Common Fill and Compaction	48,519	cubic yard	$10.87	1	$527,192
Seed/Mulch/Fertilizer (Hydroseed)	168	MSF	$41.50	1	$6,951
Confirmation Soil Samples/Analysis	67	each	$100.00	1	$6,700
Subtotal Direct Capital Costs					$12,600,058
Overhead and Profit (10%)					$1,260,006
Total Direct Capital Costs (Rounded to Nearest $10,000)					$13,860,000
Contingency Allowance (15%)					$2,079,000
Total Capital Costs (Rounded to Nearest $10,000)					***$15,940,000***

Notes:

* The factors represent adjustments for difficulty, size, and other intangibles that will affect the work.
** As a result of rounding, the amount in the Cost column may be slightly different than the product of the values in the Quantity, Cost/Unit, and Factor columns.
MSF = 1,000 square feet
-- = Not applicable

PFE ORIGINAL

REMOVAL ACTION COST ANALYSIS
ALTERNATIVE 8
EXCAVATION, DEBRIS SCREENING, ON-SITE SOIL WASHING, AND OFF-SITE DISPOSAL
12TH STREET LANDFILL/DUMP SITE
WILMINGTON, NEW CASTLE COUNTY, DELAWARE

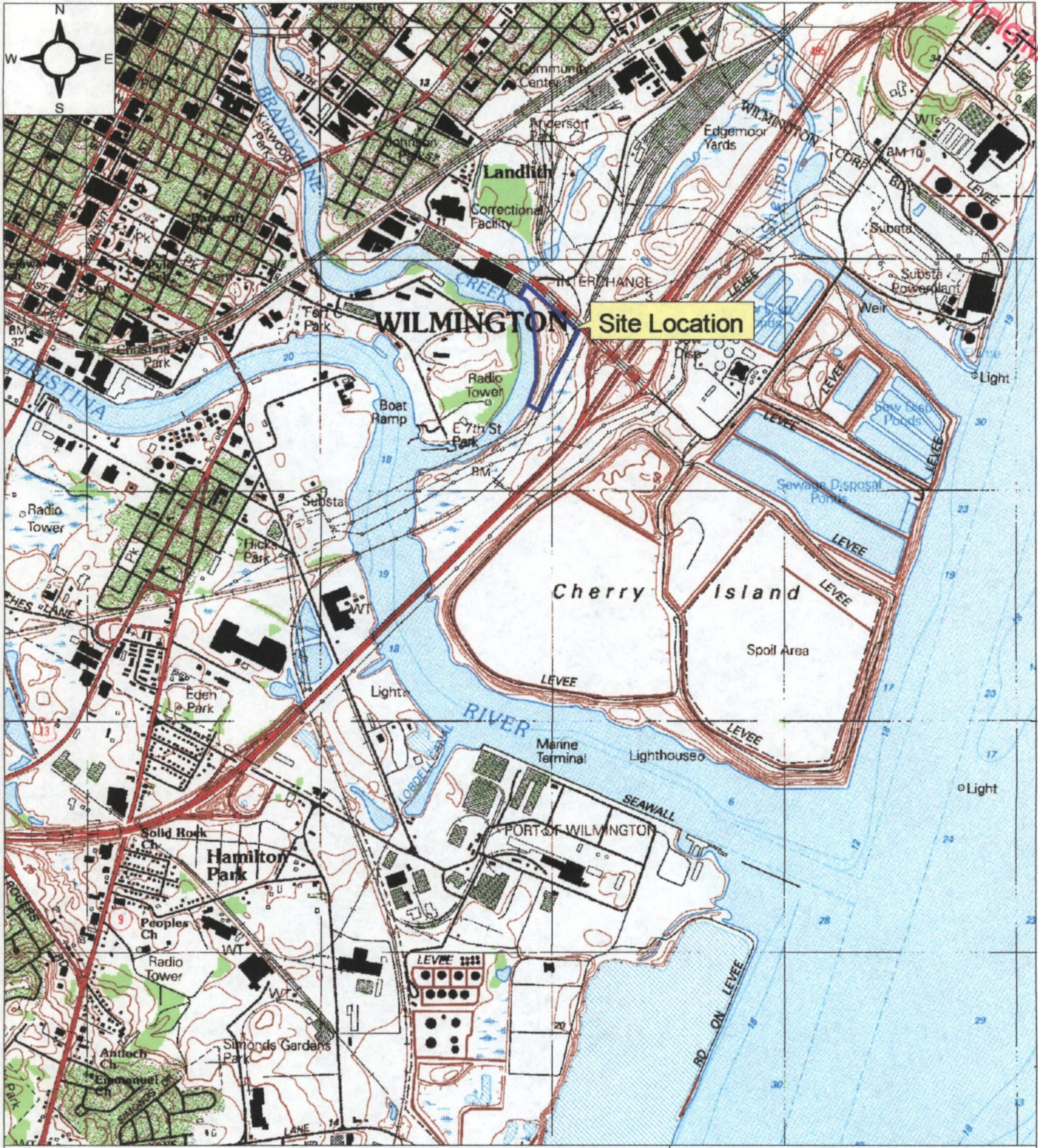
Capital Costs					
Item Description	**Quantity**	**Unit**	**Cost/Unit**	**Factor ***	**Cost ****
Direct Capital Costs					
Health and Safety Monitoring	25	month	$8,534.14	1	$213,973
Dust Control	25	month	$10,900.00	1	$273,292
Field Overhead	25	month	$34,330.00	1	$860,743
Mobilization/Demobilization	1	Lump Sum	--	5	$258,570
Silt Fencing	2,500	linear foot	$0.68	1	$1,700
Place and Remove Hay Bales	16	ton	$287.50	1	$4,600
Excavate, Stockpile, and Backfill Soil Cover	11,667	cubic yard	$9.89	1	$115,392
Excavate and Haul Contaminated Soil to Treatment Unit	60,833	cubic yard	$7.49	1	$455,752
Debris Screening	9,028	ton	$4.45	1	$40,134
Soil Washing	81,250	ton	$91.03	1	$7,396,188
Transportation of Soil Fines to Disposal Facility	131,250	loaded mile	$3.15	1	$413,438
Disposal of Soil Fines at Subtitle C Landfill	7,875	ton	$105.00	1	$826,875
Transportation of Debris to Disposal Facility	15,046	loaded mile	$3.15	1	$47,396
Disposal of Debris at Subtitle D Landfill	9,028	ton	$35.00	1	$315,972
Backfill with Imported Common Fill and Compaction	4,917	cubic yard	$10.87	1	$53,423
Backfill with Treated Soil and Compaction	44,250	cubic yard	$5.47	1	$241,832
Seed/Mulch/Fertilizer (Hydroseed)	168	MSF	$41.50	1	$6,951
Confirmation Soil Samples/Analysis	67	each	$100.00	1	$6,700
Subtotal Direct Capital Costs					$11,532,931
Overhead and Profit (10%)					$1,153,293
Total Direct Capital Costs (Rounded to Nearest $10,000)					$12,690,000
Contingency Allowance (15%)					$1,903,500
Total Capital Costs (Rounded to Nearest $10,000)					***$14,590,000***

Notes:

* The factors represent adjustments for difficulty, size, and other intangibles that will affect the work.
** As a result of rounding, the amount in the Cost column may be slightly different than the product of the values in the Quantity, Cost/Unit, and Factor columns.
MSF = 1,000 square feet
-- = Not applicable

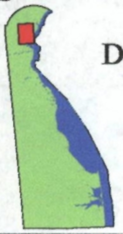
PFE ORIGINAL

FIGURES



Source: Modified from USGS 7.5-Minute Series Topographic Quadrangles, Wilmington South, Delaware - New Jersey, 1993

Quadrangle Location =

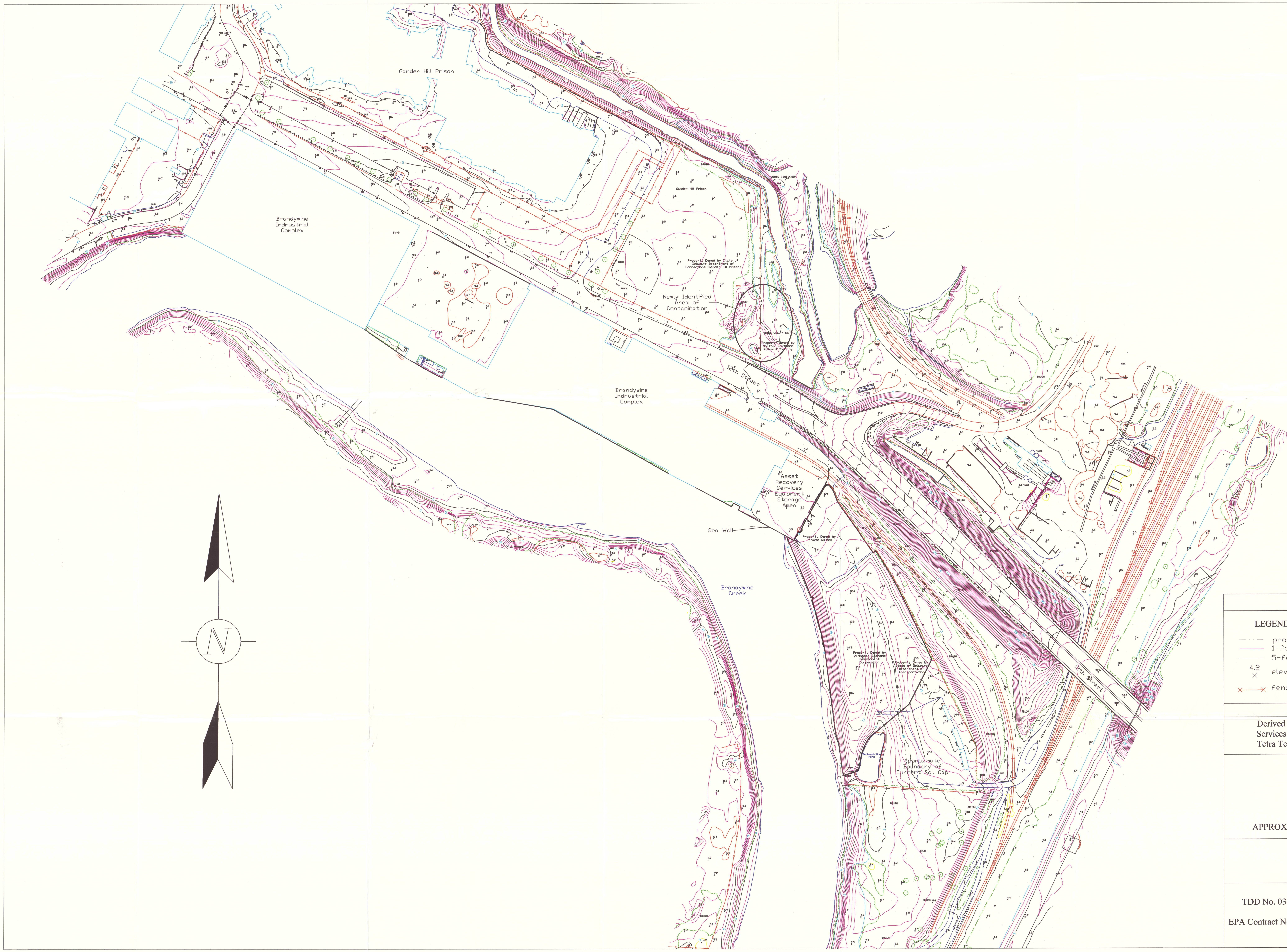


12th Street Landfill Site
Wilmington, New Castle County, Delaware

Figure 1
Site Location Map

TDD No. 03-00-07-003
EPA Contract No. 68-S3-00-02

Tetra Tech EM Inc.



LEGEND

LEGEND INFOMATION

- property line
- 1-foot contour interval
- 5-foot contour interval
- 4.2 × elevation point (feet above mean sea level)
- fenceline

SCALE

1 inch = 80 feet

SOURCE INFORMATION

Derived from New Aerial Photography and Digital Topographic Mapping Services Conducted by PROMAPs Inc. under subcontract to Tetra Tech EM Inc.

12th Street Landfill/Dump Site
Wilmington, New Castle County
Delaware

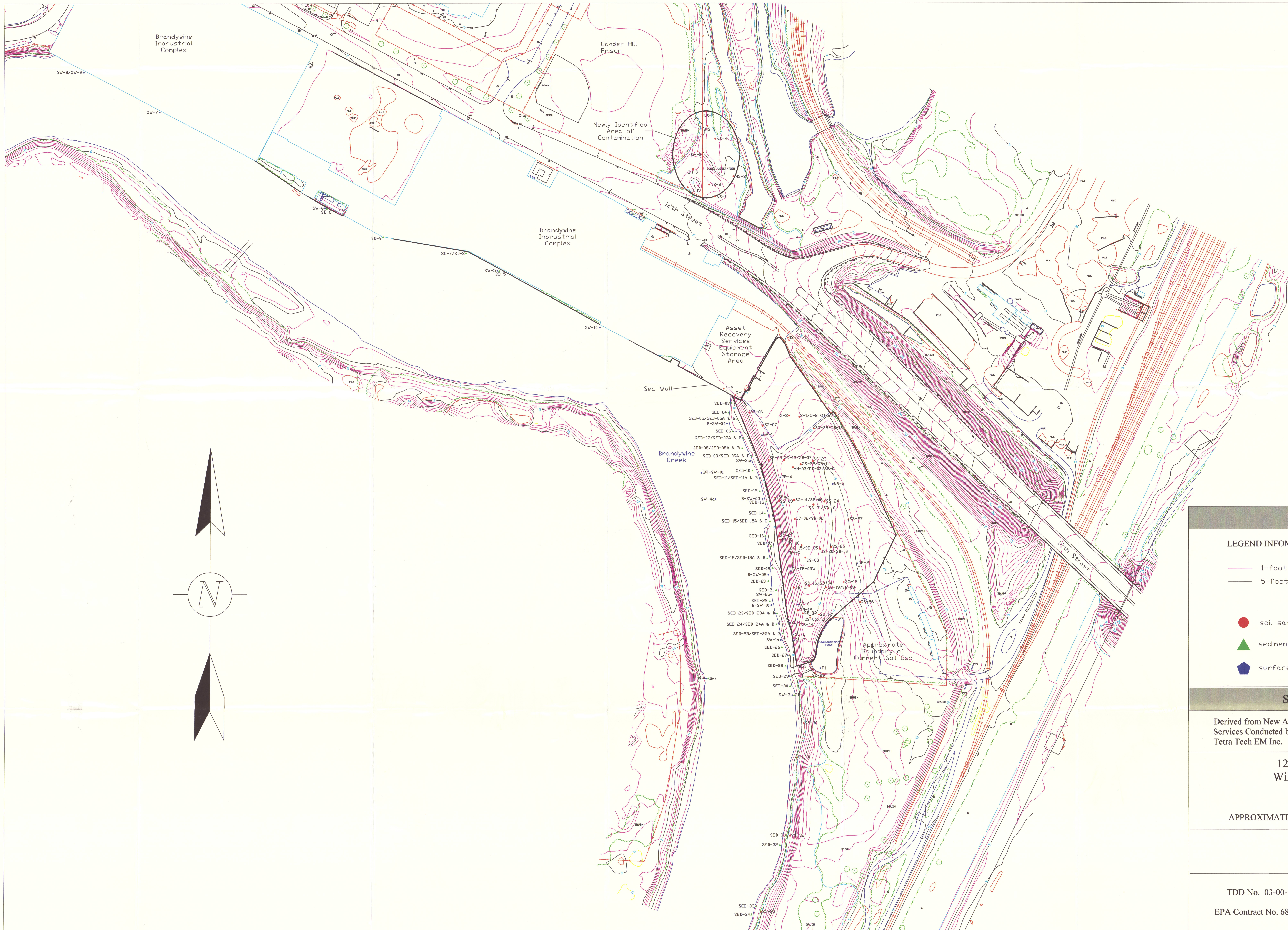
APPROXIMATE SITE COORDINATES: 39°44'15"N, 75°31'35"W

FIGURE 2
Site Layout Map

TDD No. 03-00-11-002

EPA Contract No. 68-S3-00-02

TETRA TECH EM INC.



LEGEND

LEGEND INFOMATION

SCALE

1 inch = 70 feet

1-foot contour interval

5-foot contour interval

soil sampling location

sediment sampling location

surface water/groundwater sampling location

SOURCE INFORMATION

Derived from New Aerial Photography and Digital Topographic Mapping Services Conducted by PROMAPs Inc. under subcontract to Tetra Tech EM Inc.

PFE ORIGINAL

12th Street Landfill/Dump Site
Wilmington, New Castle County
Delaware

APPROXIMATE SITE COORDINATES: 39°44'15"N, 75°31'35"W

Figure 3
Sampling Location Map

TDD No. 03-00-11-002

EPA Contract No. 68-S3-00-02

TETRA TECH EM INC.